This Month's Cover: Tube filler, built by Arthur Colton Co., automatically unloads empty tubes from shipping carton, cleans, panels, fills, closes, crimps, and ejects tubes into cartoner at rates up to 9000 an hour.

MACHINE DESIGN

Vol. 22—No. 6 **June, 1950**

THE PROFESSIONAL JOURNAL OF CHIEF ENGINEERS AND DESIGNERS

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DESIGNING FOR PRODUCTION AND SALES • STYLING
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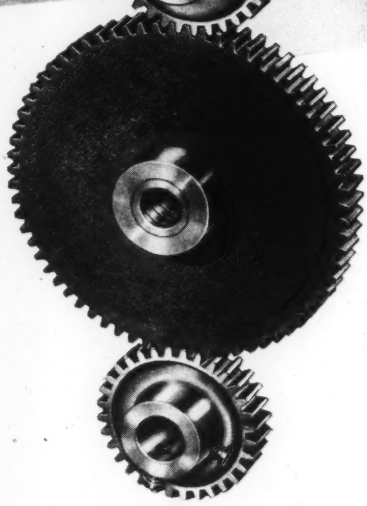

UNION SPECIAL MACHINE CO. of Chicago stresses the *"performance leadership"* of their improved Lockstitch Sewing Machine pictured above. It offers—1. High production, 2. Fast acceleration, 3. Low maintenance, 4. Dependability, 5. Quality work, 6. Easy operation. Foremost among the parts responsible for the brilliant performance and long life of this excellent sewing equipment is G.S. Fractional Horsepower Gearing. Manufactured in production runs, with almost uncanny precision and uniformity, G.S. Small Gearing is specified by many of our country's most particular buyers from coast-to-coast. If your product calls for Gearing from 12 to 96 D.P. you are sure to benefit by submitting your needs to our skillful engineers. You see, we've been making *better* Fractional Horsepower Gearing *exclusively* for over 30 years! You can expect production runs uniformly made to the most exacting specifications from any type of materials, and *delivered on schedule.* Write today for suggestions, ideas and cost estimates. No obligation.

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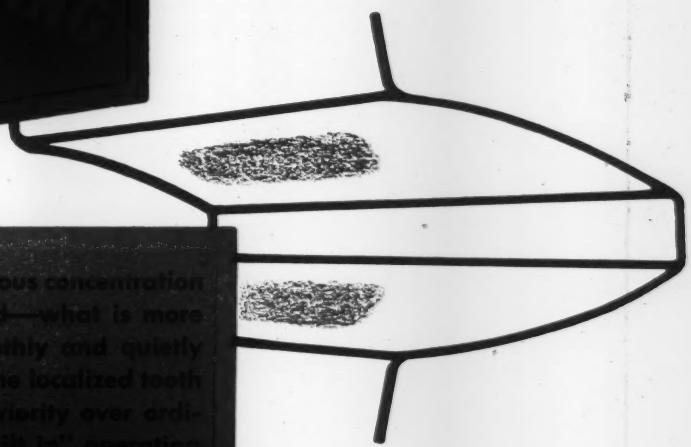
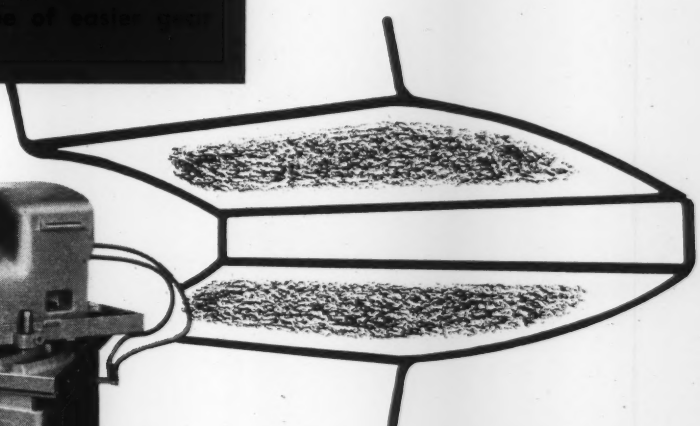
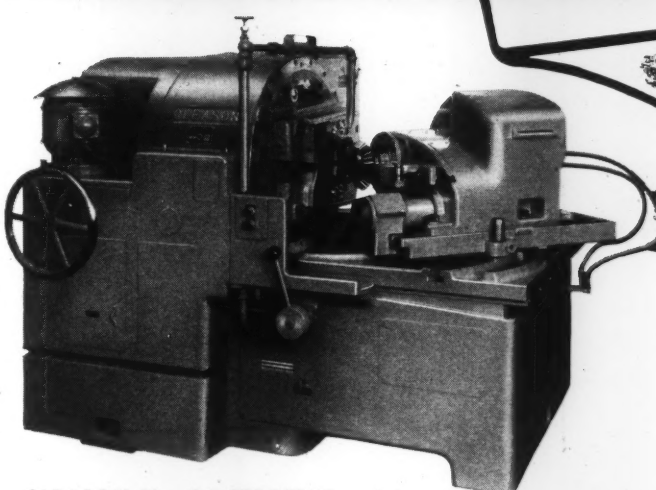


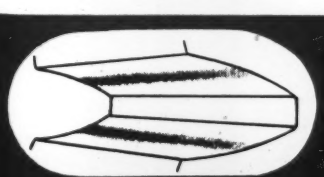
Coniflex* gears have no dangerous concentration of load on the ends of the teeth and—what is more important—Coniflex gears run smoothly and quietly with a safe distribution of load. It is the localized tooth bearing that identifies Coniflex superiority over ordinary straight bevels . . . it is the "built in" operating clearance that provides safe distribution of load. This "built in" feature, automatically produced during the cutting operation, is your guarantee of easier gear assembly and ideal gear operation.





GLEASON No. 14 STRAIGHT BEVEL GENERATOR

The Gleason No. 14 Straight Bevel Generator is the Coniflex generator for medium size gears. Other models are available for the cutting of gears for small tools and appliances or for large industrial gears. These machines are all equipped with simplified controls to produce a Coniflex bearing during gear manufacture.



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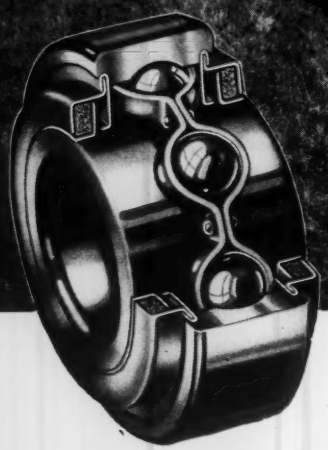

Seven of these New Departure Lubricated-for-Life ball bearings are used in the feeder rollers and feeder apron.

AT seven important bearing positions in the J. I. Case Sliced Hay Bailer, oiling or greasing has been eliminated — maintenance by the operator has been reduced to precisely zero!

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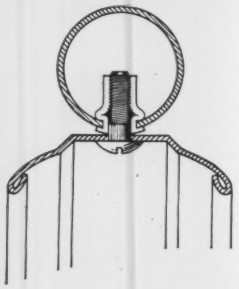
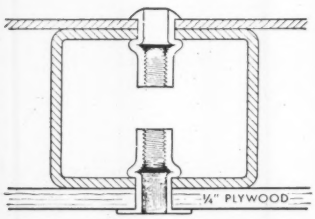
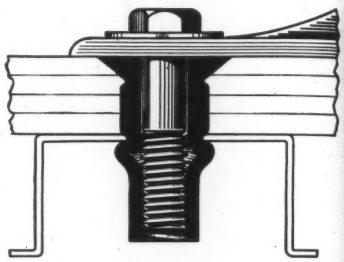
RIVNUTS solve tough fastening problems



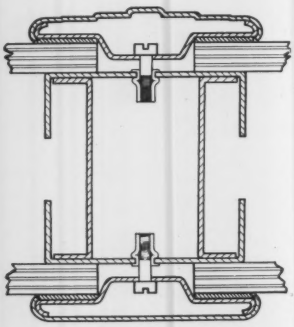
1 **TO ATTACH A MUDGUARD** to a bicycle's tubular frame, designers used a standard flat-head Rivnut. The correct radius was ground into the anvil of the heading tool, which curved the Rivnut head at the same time the bulge was formed. The still-intact Rivnut threads provided a firm anchor for the attachment screw.



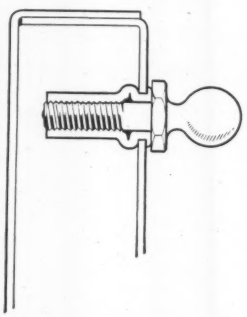
2 **RIVNUT AT BOTTOM** (above) fastens plywood walls to tubular steel sections in trailer. Large washer head and bulge in shank prevent Rivnut pulling through plywood or vibrating loose. Rivnut at top rivets steel sheet to opposite side of section. *One man* can install a Rivnut from one side of work *in two seconds*.



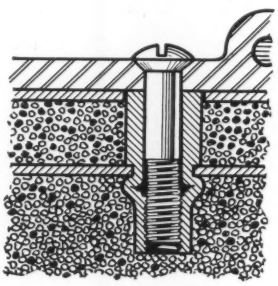
3 **BUS DESIGNERS** used Rivnuts—*the only one-piece blind rivet with threads*—to fasten seats to plywood floor board. Heading tool upset Rivnut, forming bulge under floor board. Splines on Rivnut shank took care of torque. At least 6 Rivnut threads remained clean to grip attachment screw. Many man-hours were saved in assembly.



4 **THE PORCELAIN STEEL WALLS** of this pre-fabricated building are securely fastened, yet easily removable for moving or repairs—thanks to Rivnuts. Installation is made by one man from one side of studding. Rivnuts require only very small hole, provide wide bearing surface. Cap screws threaded into Rivnuts attach walls.



5 **THREE PROBLEMS WERE SOLVED** by Rivnuts in this kitchen cabinet door. (1) Rivnut was installed from one side only, (2) It furnished at least 6 clean threads for attaching knob, and (3) It was installed *after* enameling without marring the finish. Rivnuts improved product quality, saved many man-hours on this job.



6 **WALK-IN REFRIGERATOR** uses special-type Rivnuts to attach hinges to door made of steel sheets and sponge insulation. Spacer head allows upsetting of Rivnuts deep in door. Rivnuts form compression fit which—combined with closed Rivnut end—provides positive sealing. Clean threads take hinge attachment screws.

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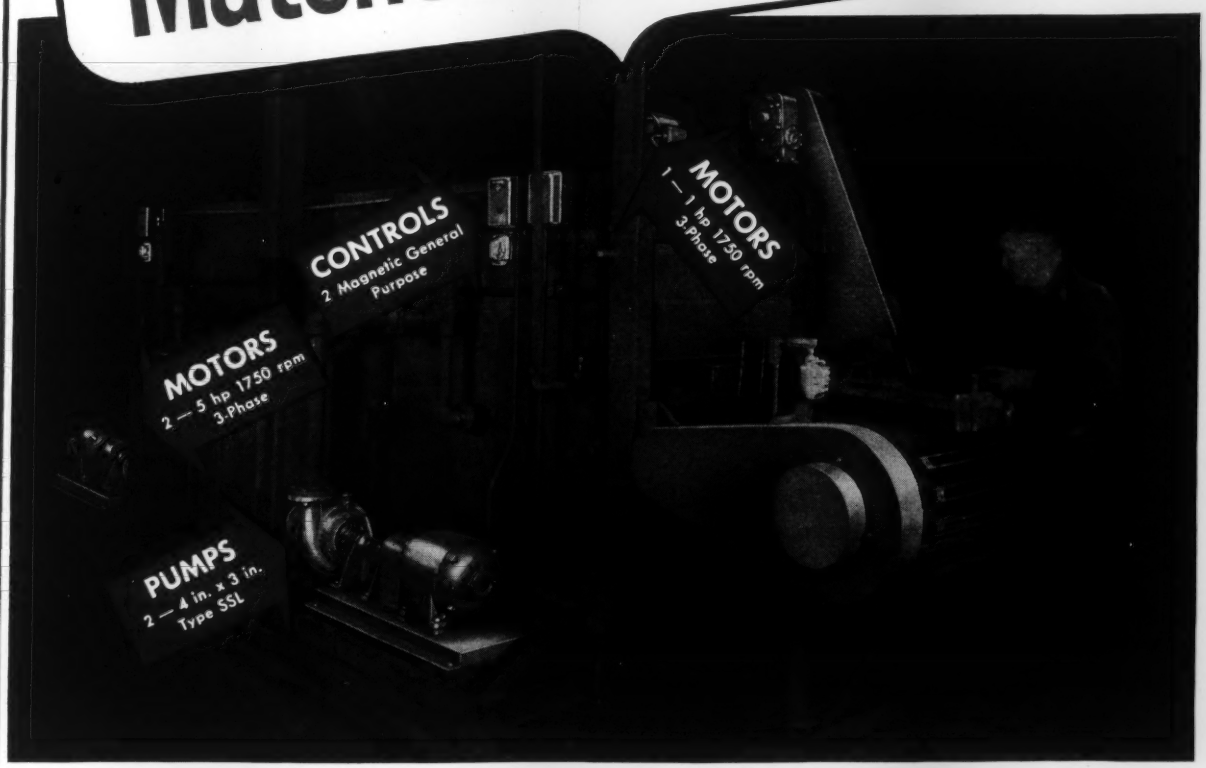

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TOPICS

HIGH TEMPERATURE LUBRICATION is provided by a combination of a silicone-polymer fluid and its decomposition product, according to an NACA report from Lewis Flight Propulsion Laboratory. Formed by heating, these decomposition films showed the same general range of friction values as those obtained under boundary lubrication conditions for the original fluid lubricants. Although neither a silicone-polymer fluid nor its decomposition product alone showed sufficient film strength, acceptable results were obtained by using the combination at surface stresses approximating the maximum commonly used in aircraft power plants.

THERMAL EXPANSION ALLOYS with the same coefficient as glass have been developed for lead-in wires of parts such as sealed beam headlights and television tubes.

INDUSTRIAL TELEVISION is now available in an integrated, ready-to-operate unit. Dumont Laboratories recently announced a 12½-in. screen, 525-line, color system complete with camera, connecting units and viewing monitor. Its application is anticipated in research, educational, factory-management, medical, and merchandising fields.

SUBMINIATURE RADIO TUBE developed by the Air Materiel Command's Components and Systems Lab requires only 1/90 of the space taken up by a standard tube. Not yet available for civilian use, the "fieldistor" is being developed as one phase of the program under way in the USAF to reduce the size and weight of aircraft equipment. Small size and structure of the tiny tubes will enable them to better withstand engine vibration, gunfire damage, and landing shock.

OSCULOMETER is the name given a device useful in determining the curvature and the second derivative at any point on a plotted curve. In a method developed by H. L. Curtis of the Bureau of Standards, curvature is read by direct comparison of the experimental curve with the osculometer, essentially only a piece of transparent material containing a series of arcs of known curvature. Slope is determined with a protractor by measuring the angle between the base of the osculometer and the x axis. The corresponding second derivative is then obtained by a simple calculation.

CONSTANT CUTTING SPEED for contour turning lathes has been provided by a new approach reported by R. C. Montanus of the Springfield Machine Tool Co. Diameter properties of the contour template are transmitted by a cam system to a reactor unit. Variation in position of the reactor armature alters speed of the drive to suit contour diameter. The electrical drive consists of a Westinghouse variable voltage motor-generator set of constant horsepower with electronic field control.

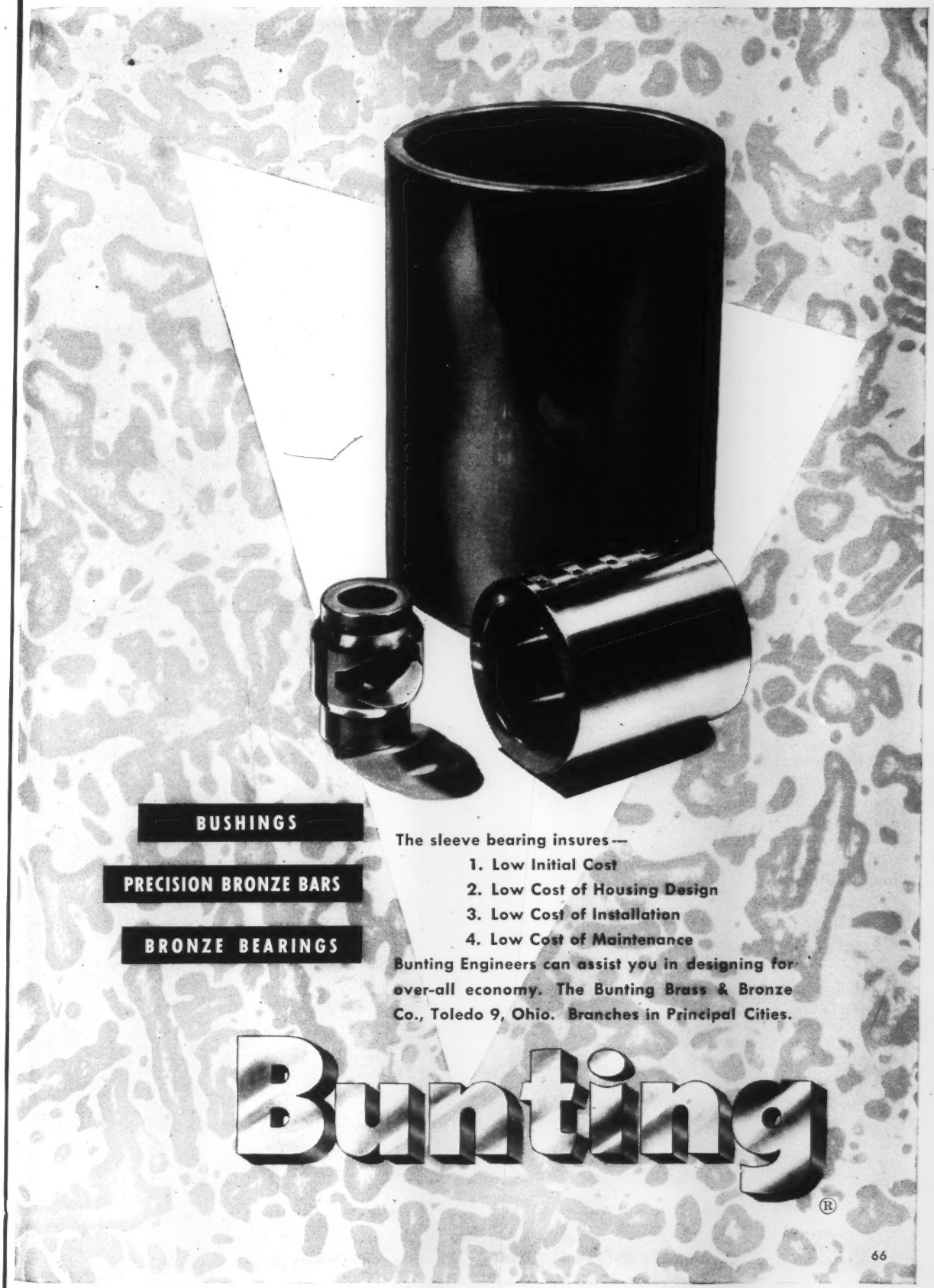
ALERTNESS INDICATOR which signals lethargy of persons performing monotonous work has been developed for the Navy by Tufts College. An electronically controlled recorder sounds warnings when the measured alertness becomes dangerously low.

TITANIUM ALLOY as strong as high-strength steel but only half as heavy has been developed by the Navy Bureau of Aeronautics for use in the construction of jet planes and engines. Composed of 92 per cent titanium, 5 chromium and 3 aluminum, the alloy is highly resistant to corrosion and retains its basic properties at high temperatures. It is being used in turbine blades, tailpipe shrouds, engine firewalls, and other components where strength at high temperatures is important.

GLASS RIBBON is being used as the dielectric, and aluminum foil as the electrodes, in small, inexpensive condensers developed by the Corning Glass Works under Army Signal Corps contract. Condensers are sealed in glass cases that are impervious to atmospheric moisture and other climatic effects.

BARIUM TITANATE is being used in transducers which convert electrical into mechanical vibrations. According to GE engineers, transducers may be molded into any desired shape when using this newly developed compound.

XUM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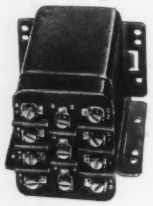

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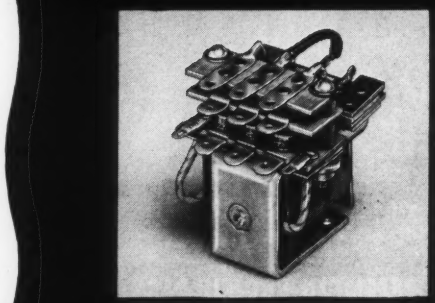

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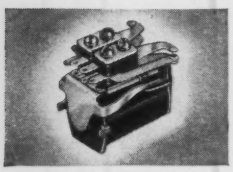

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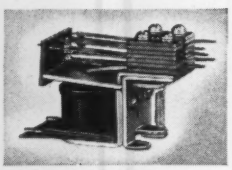

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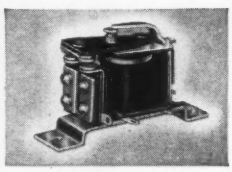

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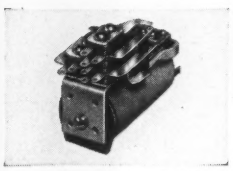

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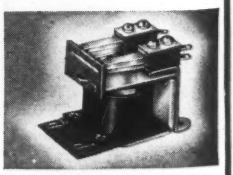

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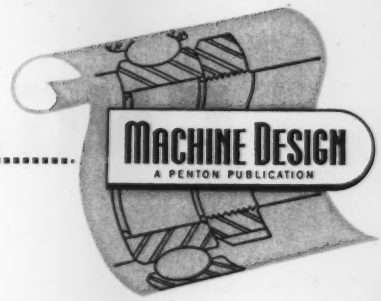


Economy in Engineering

MUCH is being said and written today about the effect of tolerance specifications on the cost of producing machine parts. Designers are constantly being exhorted to keep tolerances as liberal as the functioning of the machine will permit.

But what about tolerances in engineering work itself? Tolerances in calculations, in research, in development studies? In other words, how much "fussing" should engineering management expect, to insure an adequate design?

Some self-styled practical engineers used to delight in telling stories at the expense of the so-called theoretical engineer who spent days and weeks on intricate calculations only to produce a machine which failed on its first test. Then the more highly trained engineers would counter with their own brand of heavy-handed humor, telling tales of the blundering efforts of ignorant designers who didn't know enough to make a few simple check calculations before proceeding to build a machine.

As the victim of the first story presumably learned to his sorrow, attempts to establish engineering data with extreme precision do not of themselves insure the success of a machine any more than do close dimensional tolerances. On the other hand, failure to employ any sort of scientific aid to judgment is equally impractical—the success or failure of the machine then becomes purely a matter of chance.

Just what degree of precision is actually required in a particular design is something which engineering management needs to establish clearly in the mind of each designer working on the project. Perhaps the necessary calculations merely establish an order of magnitude, in which case it is a foolish waste of time and effort to strive for an accuracy of one or two per cent, especially if the data on which calculations are based represent mere guesses that could be 50 or 100 per cent off. Perhaps, on the other hand, certain features of a design are highly critical, in which case there is ample justification for going "all out" for precision. By viewing design analyses and calculations in their proper perspective, management will achieve an economy in engineering which will balance the much sought after economy in actual production.

Colin Carmichael

EDITOR

ENGINEERING MA

The whys and wherefores of engineering management, how it is organized and carried out from the inception of an idea to the finished machine or product

By Randolph W. Chaffee
Consulting Engineer
Cleveland, Ohio

Part 1—Responsibilities of Engineering

FEW people realize how important to their own personal welfare the American conception of engineering really is. Most take for granted that anyone with a dollar on hand can walk into a store and purchase a serviceable fountain pen, needed medicine, a cigarette lighter, a meal or any one of a thousand useful products and services. They take for granted also the stores' plentiful stocks of clothing, appliances, furniture, china, and everything one can want, while citizens of nearly every other country on the globe are closely rationed to less than minimum needs, must stand in line for hours or do without nine out of every ten products which Americans enjoy daily and at will.

Political dogma may restrict a country's industrial economy and its supply of goods, and limited natural resources also dampen a nation's industrial growth but these are but the superficial symptoms of an underlying void. During its first struggling years, America was shackled by political dogma and by ignorance of the existence and the methods of exploiting its natural resources. But America "engineered" itself free of these shackles to become a dominant world power within the span of a few generations.

THE IMPORTANCE OF ENGINEERING: What is this engineering magic by which a nation has attained dominance in the World's commerce and industry in less than 200 years? Your definition and mine will not be worded alike but they will mean the same.

When an industrial project, enterprise or product is engineered, as Americans understand the term, every phase and element is thought through in advance. We preplan sales potential; marketing methods; acceptable price and costs; function, style and sales appeal; maintenance and service; resale and reuse and every other influence which will bear upon the enterprise, project or product. As a result of this exhaustive process, we know exactly how we will inaugurate, direct and conclude the project and what its whole outcome will be, as closely as human ingenuity makes possible. Knowing these things, we are qualified and willing to invest vast sums of money and superior talent in the design, plant, tooling, labor and materials that will be needed to turn out tremendous quantities of product or services at lowest cost. Thus, we enable multitudes of people to enjoy the utility, comfort and prestige of our product.

It is this careful, accurate and complete preplanning or "engineering" of industrial and commercial operations which distinguishes America from other countries and which comprises the magic of American pre-eminent industrial performance.

As engineering is the keystone of American industrial economy as a whole, so is engineering the

"... tremendous quantities of product ... at lowest cost ..."

Photo, courtesy Hotpoint Inc.

AGEMENT—Its Job

keystone of success in the individual industrial enterprise. Without this engineering, there would be no great quantities of steel as supplied, for instance, by the United States Steel Corporation, no nationwide communication as provided by American Telephone & Telegraph Company, no millions of automobiles for fast and cheap transporatation, no chemicals and synthetic materials, or other facilities which make possible food, health, education, and security which are beyond the reach of 80 per cent of the Earth's peoples.

Nor is engineering important only to the larger industrial empires. In fact, more than the lion's share of engineering is carried on by countless smaller establishments developing the modern applied sciences of electronics, optics sound radiation, radioactivity, nuclear energy, and a host of others which contribute to our health, wealth, happiness and security.

Let us agree, at this point, that engineering is not only the heart and core of American industrial supremacy but also that it is essential to the survival of every unit in the American industrial and commercial system. What, then, is the modus operandi of engineering—its responsibilities, scope and organization, and how is it carried on?

We are concerned here not with operative engineering, such as the running of a power plant, railroad locomotive or steamship, but with creative engineering which involves invention of improved methods for lower cost and greater utility. We seek, creatively, practical contribution to users' comfort, efficiency and prestige; stable sales volume; reasonable profits for the owners and managers of business enterprises; stable employment of workers; military security and, through all of these, preservation of the free and democratic political economy.

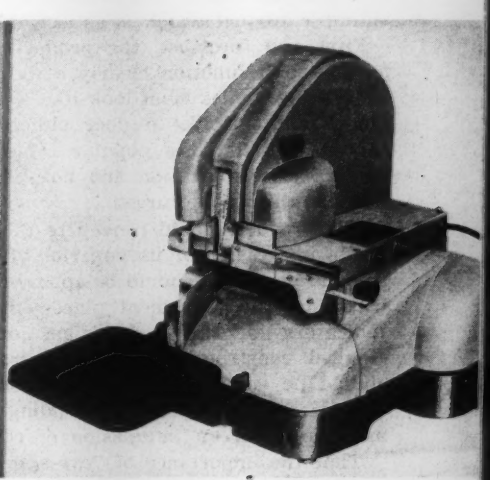
THE RESPONSIBILITIES OF ENGINEERING: Engineering may be regarded as the practice field, the dress rehearsal and the proving-ground of industry and commerce. As such, engineering has many objectives and responsibilities of which we can name but a few of the more important here.

Responsibility to Users: A prime objective of engineering is the service of its product to users and only as this service is rendered is there a reason for engineering. The product of engineering must fulfill a definite need which may be recognized and crystallized in an existing demand, or which can be stimulated and created for the greater benefit of users. As the 21-inch domestic power lawnmower fulfills a specific need better than the 16-inch hand mower, so do most of the current products of engineering fulfill an old need better.

The product of engineering must be functional and practical. The familiar paper-stapling machine is functional and practical. On the other hand, we do not "engineer" styles in ladies hats. The product of engineering also must be durable and dependable so that the user may enjoy long and uninterrupted use of the product, commensurate with its cost. It is possible to build a flimsy industrial fork-lift truck which breaks down often and denies its owner normal use of the machine but the integrity of this type of engineering may be questioned.

On the other hand, it is possible to provide value and service life in the product far beyond the ability of the user to recover. While visiting a plant manufacturing domestic washing machines a few years ago,

". . . a product that speaks for itself clearly and forcefully . . ."



Photo, courtesy Dennison Manufacturing Co.

RANDOLPH W. CHAFFEE, registered professional engineer, has had extensive experience in industrial engineering and engineering administration. Prior to his present practice he was director of engineering for a seventy-man professional creative engineering group. During the recent war he served in combat zone duty with the U. S. Army Air Forces in supply planning. During the period following his graduation in 1923 from Tufts College Engineering School in electrical engineering, he engaged both in private practice and with various consulting firms as staff industrial engineer. He recently spent several years abroad on engineering assignments.

the writer was shown a nonautomatic, open-top tub-type running in the testing laboratory. The owner of the business announced with great pride that the machine had been running for a period equivalent, in average household service, of 144 years! In the mechanism under the tub a lever, which translates the rotary motion of the drive into reciprocating motion of the vertical dasher and which transmitted 1/3 horsepower, was a malleable casting of H section 1¼ inches wide or heavy enough to transmit 15 horsepower. The buyer of this washer was compelled to purchase 144 years' worth of service with the prospect of recovering no more than one-seventh of his investment. Today, five years later, the open-tub washer has become obsolete and a fully automatic machine can be bought for less money.

Sound engineering allows the user to recover all or nearly all of his investment during the prospective period of style life and usefulness to him. Many other responsibilities of engineering to users, which are too numerous for discussion, could be mentioned.

Responsibility to the Sales Function: The products of engineering must be "sold" by persons skilled in the art of selling but not in the technology of the products and engineering must be responsible for providing a product which is as easy to sell as possible.

First and foremost, the product must display its purpose and function clearly at a glance. A device for peeling apples must look like a device for peeling apples and not like a door chime. An automobile should look like the popular concept of a common mode of transportation and not like a 17th-century Dresden china soup tureen.

The product should convey to the observer a composite impression of its superior virtues. Its ease of use and operation should be apparent at once as illustrated by the convenient placement of controls and indicators on the modern gas or electric range. Rugged construction and long, trouble-free service should be engineered into the products' appearance even if only possible by shrouding complex innards and conveying an impression of compact simplicity.

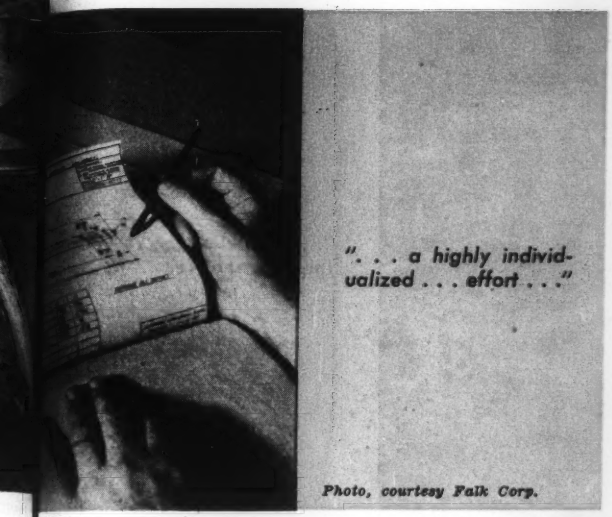
That the importance of "eye-appeal" is well recognized is painfully evident in the many garish nightmares now thrust upon us. There is little aesthetic virtue in the costly, bulging "streamlined" toaster which sits immobile on the dining room table. Fortunately we are recovering from the mania for rococo streamlining and are learning to design into our products simple, smooth and well-integrated dignity which not only reduces cost but also enhances prestige.

Engineering aids the selling function when it employs in the right places, modern materials and art that have popular appeal to the layman. Nylon is one of these, at present, together with other plastics, aluminum and magnesium for light weight, fluorescent illumination, detergents and wetting agents, electronics, multiplicity-of-purpose, automaticity of reaction and indication, and a host of others that clothe the product with an aura of modernity.

Good Product Sells Itself

In a word, engineering discharges its responsibility to the sales function when it offers a product that speaks for itself clearly and forcefully in pictorial and textual advertising, on the counter and display floor and in its impact upon observer consciousness. With this product, the sales department can concentrate it efforts and resources upon reaching the widest market in the least time and at least cost.

Responsibility to Ownership and Management: Quite apart from its responsibility to industrial ownership and management, as an employee earning a pay check for doing a specified task, engineering has a broader obligation. Engineering exercises its own independent initiative and judgment, its special skills and its creative instincts in developments that only engineering itself can assess or evaluate. Superior management is not qualified to assess the products of engineering nor should management attempt to do so except in very broad and general terms. Engineering can and should stand squarely on its own two feet, vested with the trust and confidence of management and free to employ its technical, ethical and professional tenets as it sees fit.



". . . a highly individualized . . . effort . . ."

Photo, courtesy Falk Corp.

Engineering is responsible, in large measure, for production costs and operating profits. Engineering must know the allowable selling prices and it must provide designs that can be made at a cost allowing a reasonable profit.

The era of cheap labor is gone—probably forever. Products cannot now be produced economically by hordes of unskilled workers doing many simple manual tasks at minimal wage rates. Rather, manufacturing workers will demand and get high wage rates and it is the responsibility of engineering to permit and encourage the highest productivity of factory workers so that unit costs stay down while wage rates stay up. This means engineering for fewest parts and interchangeability of parts; reasonable tolerances and design for easy assembly; standardization of dimension and method; economic tooling and many other aids that enable the factory workers to turn out the most product in the least time and with least effort.

Engineering is responsible to ownership and management for profits, not only for the benefit of stockholders and the surplus account, but also for the benefit of sustained high wages and employment security of workers.

Professional Responsibilty: It is a responsibility of those who practice engineering to assure the professional status of this work and of all those who engage in it. Among other things, the individual practitioner subordinates selfish motives to his contribution to the profession and to its beneficiaries.

Professional practice is a highly individualized and a highly personalized effort, in the same manner that a surgical operation is the product of the personal training and experience of the surgeon. The professional practitioner tends to guard, cherish and defend his individual status, point-of-view and principles. This is right and just. Without the incentive of individual professional attainment, we could not develop fully the urge to create, invent and perfect.

In engineering, however, individualism can become a hazard when engineers cannot co-operate and work together on a healthy, give-and-take basis without undue pride or prejudice, to supply the best composite thinking and to strive harmoniously for the maximum group achievement.

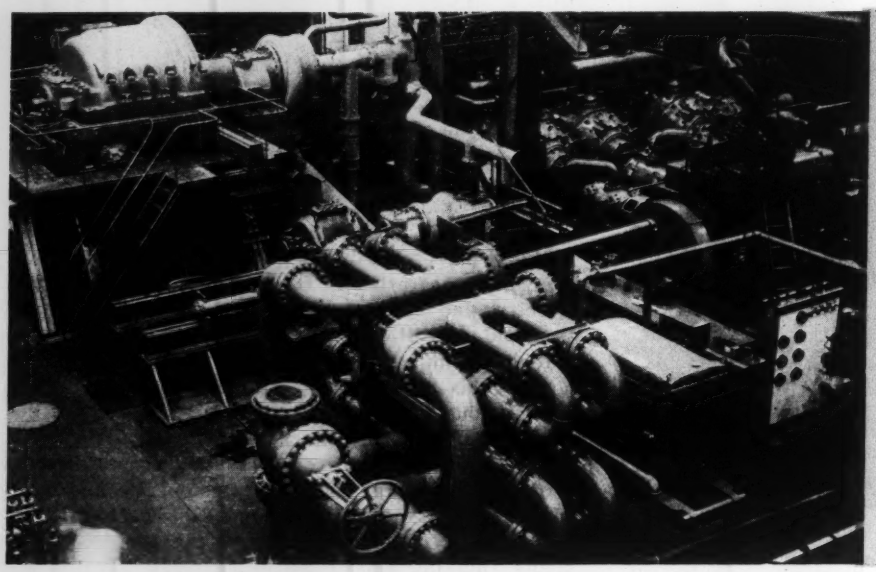
The professional practitioner does not clutch to his bosom the fruits of his research, hoping to profit personally from the exclusive possession of special knowledge. Rather, he foreswears personal gain and offers freely to his fellow professionals his special knowledge to the end that the whole profession shall employ this knowledge and the whole people shall benefit thereby. This, too, is a part of the professional responsibility of engineering.

Captive engineers, i.e., engineering personnel employed by a manufacturer for the engineering of his products exclusively, can sustain and advance the manufacturer's reputation as an employer of engineering. Captive engineers, wearing the employer's mantle, should affiliate themselves with recognized engineering and professional societies, engage in technical discussions, present technical papers and otherwise let it be known in a dignified manner that their companies are active supporters of the engineering profession.

The responsibility of engineering practice to the

". . . to avoid wasteful trial-and-error . . ."

Improvement & Forge Co.
Photo, courtesy Steel



". . . to define the remaining imponderables . . . and test . . ."

Photo, courtesy Clark Bros. Inc.

profession includes the support and taking of group action, through recognized engineering and professional societies, to perfect, advance and protect the ethics of engineering practice.

THE SCOPE OF ENGINEERING: The scope of engineering seems to be the creation of the whole pattern for a needed enterprise, project or product in industry and commerce. As here used, the term "pattern" refers to the overall plan which is brought in detailed form to the point where others may take over and put the plan into actual operation. It is rare indeed that the product of engineering does not involve and obligate another major branch of industry, and engineering must be closely co-ordinated with those branches through effective administration of the engineering function.

Avenue of Approach: Engineering may start when it has been determined only that a need exists. In highway engineering, it may be known only that a traffic bottleneck exists and that relief is needed. Chemical engineering may start with a new laboratory formula and with the need for a practical process for quantity processing. In the electrical or electronic fields, engineers may be called upon to produce a specified phenomenon. In design engineering, there may be a need for a specific machine or for some machine product to provide work for the plant. Industrial engineering may be called upon to create a whole new industry or branch thereof including organization structure, land and buildings, equipment and tooling, and all other facilities required to get the new business under way.

When undertaken at this early stage, engineering involves researches not commonly identified with the engineering function. To cite one example, the engineering of a new machine requires market research to determine the market requirements, the price at which it can be sold, the potential sales volume, the best channels of distribution, the requirements for packaging and display, and much other information that governs creative machine development.

This work is commonly identified as "market research", "market analysis", "sales engineering", etc., and the detail work may be done by a specialist group, including the interpretation of findings and preparation of specifications. However, the group that will undertake the technology of machine development should participate in the programming of the market analysis to assure truly informative and realistic results, and the final interpretation should be shared with the creative technicians to assure complete research results. Only by such co-ordination and joint direction can the market research effort be translated smoothly into the end products.

Patent Research Part of Design Study

The early stages of creative engineering may also include patent research for two reasons. One is to avoid conflict of the end product with prior and protected art, and to avoid costly litigation. The second, and equally important reason, is to learn from recorded art what has gone before, what has been tried, what has succeeded and what has failed, and to avoid needless duplication of technical approach.

Equally as important as patent research is the review of prior art as recorded in technical and trade literature, catalogs and specifications of parallel machines, materials and methods. This may also include critical examination or operational testing of parallel machines or methods.

The foregoing and other steps are needed to determine and clarify the avenue of approach, to avoid wasteful trial-and-error and to orient technical thinking into the right channels.

Creative Endeavor: What we here call "creative endeavor" is the very heart and core of creative engineering and includes the preliminary and final design of the process, product, machine, or method. Rarely does the first or preliminary effort generate the final and acceptable solution, however carefully the avenue of approach has been traversed. The

nd clarify major problems . . ."
. . . to resolve minor questions

Official U. S. Navy photograph

avowed purpose of the preliminary creative effort is to define the remaining imponderables, to explore and test them, and accomplish such evaluations and decisions as are needed to solve these remaining basic problems.

The preliminary creative effort may include the design, construction and operative testing of models with gaging and measurement of performance, before a selection can be made. This procedure may be confined to the laboratory, or it may go far afield in search of practical environment.

In the final creative effort, pencil is put to paper on the drafting board and the product first begins to take definite form. All of the findings and selections previously made are incorporated, and there is every reasonable assurance that the end product will fulfill its requirements nicely. All of the several engineering arts which may be involved are here brought together to make up the composite whole. The necessary details of dimension and tolerance, raw material specifications, standard parts and fastenings, methods of assembly, finishing and packaging, use and maintenance, etc., are worked into the final design effort.

The end product of creative development is all of the drawings, instructions for fabrication and assembly, bills of materials and drawings lists, color and finish specifications, layout charts and diagrams, data relating to costs of production and operation, and everything else needed for early production by others of the unit or method developed.

Records: No engineering project is complete until it has been recorded fully and the preparation of the record is an essential part of engineering. However onerous the burden of report writing, this record can best be prepared by the engineers involved and it should set forth the full history of the project with calculations, statements of alternatives and selections, sketches and working papers, test data, charts, minutes of discussions, drawings, engineering costs, etc.

This record should be prepared with the intent that any engineer may be able to retrace and comprehend the full scope of the project at any future time, and to use the record in his future avenue of approach to a similar problem.

Co-ordination of Engineering: Once upon a time, one man with one or a few assistants could undertake a creative engineering project and come up with the telegraph, the steamboat, Bessemer steel or the electric light. Today, creative engineering has become so complex that it involves many engineering arts and sciences and it requires close co-ordination with the other branches of industry.

Our complex social structure injects into creative engineering many extraneous influences of economic, moral, competitive, legal, financial, and reactionary character. The typical engineering project of today requires not only the creative fulfillment of a need but also keeping out of trouble while doing so. The end product of engineering arrives, sound of wind and limb, by avoiding the many pitfalls along the way, and this requires co-ordination.

The creative engineering function should be supervised by a liaison officer who may be titled Chief Engineer, Vice President in-charge-of-engineering or otherwise, and who operates at the same level as the Sales Manager, General Counsel, Comptroller, and Plant Manager. Co-ordination of general policy is accomplished at this level and the liaison engineering officer harmonizes the engineering function with general policy in his directions to the staff.

Limited liaison may be conducted at one or more lower levels, according to a clear pattern, to resolve minor questions and to clarify major problems before they are referred to the top level.

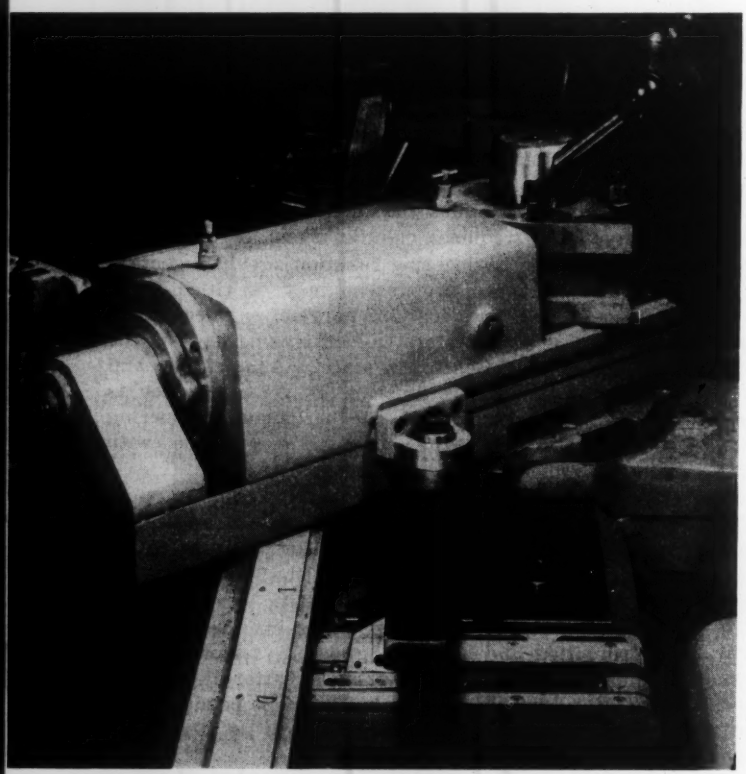
Notwithstanding the individualistic tendencies of engineers, engineering must recognize the need for co-ordination and accept it gracefully. However, co-ordination cannot be a hit-or-miss matter or the business of everybody at will, but must be conducted by designated individuals within clearly defined limits of authority and responsibility.

SCANNING the Field For Ideas

Constant cutting speed for work diameters between 2 and 12 inches is provided by the cross slide arrangement shown below on a Springfield lathe. Position of the tool controls the location of the armature in a reactor. This reactor is simply a coil with an armature suspended in its field but has no physical contact with it. By varying the position of the armature, stepless speed control of a Westinghouse variable-voltage motor-generator set drive is obtained.

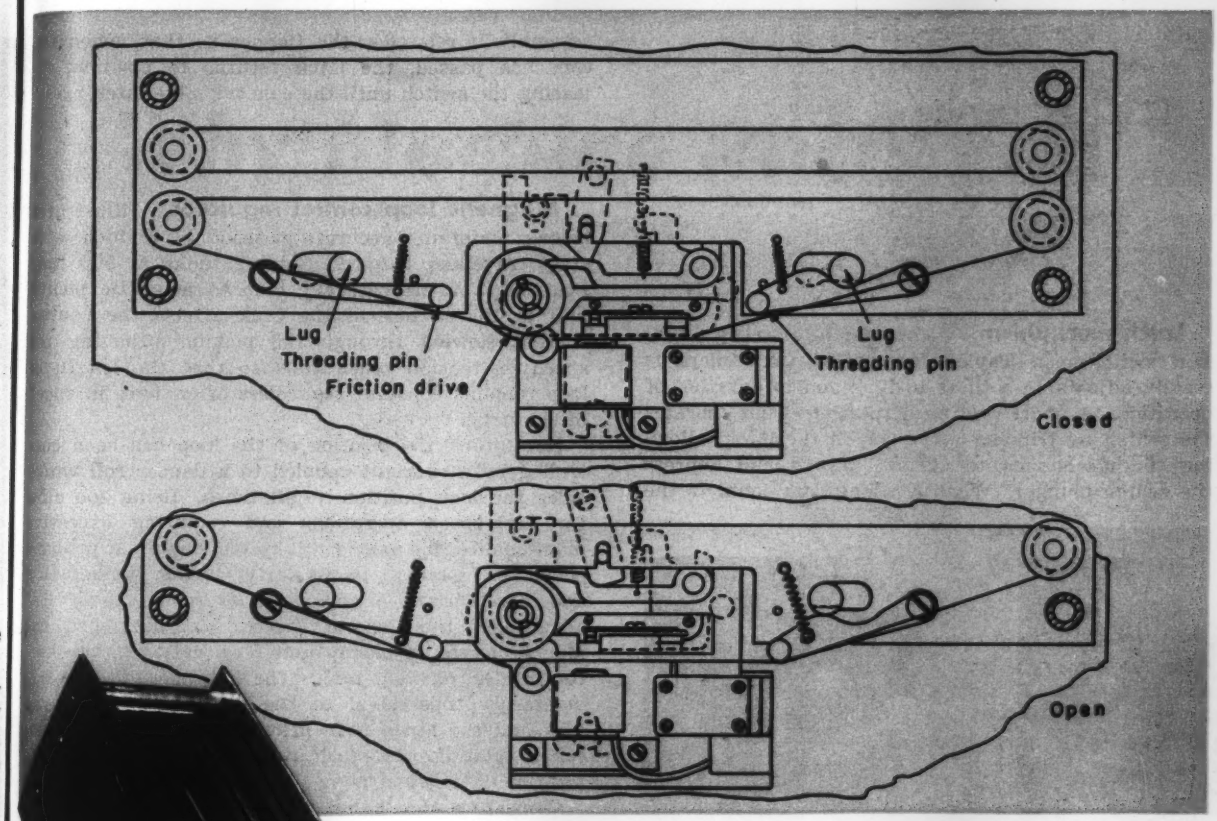
A control arm is mounted on the side of the tool slide and the reactor assembly is attached to the wing of the carriage. This assembly encloses the reactor coil, a cam follower slide and an operating cam. Movement of the slide is at 90 degrees to the longitudinal axis of the machine and, therefore, its position is a direct indication of diameter. Shape of the cam is such that it controls the reactor to give the proper spindle speed for the diameter indicated by the position of the cam follower slide. To enable the machine to operate from zero to 2-inch diameter, which is beyond the speed range of the drive, the cam is cut straight to give a constant spindle speed.

The control arm is adjustable along the entire length of the tool slide as well as angularly to it. This allows for the use of different length tools and for different angular settings of the tool slide, the arm being set parallel to the longitudinal axis of the lathe regardless of the angular setting of the slide. Essentially the unit is based upon maintaining a right-angle triangle in which the control arm is the base, the follower slide the perpendicular and the tool slide the hypotenuse.



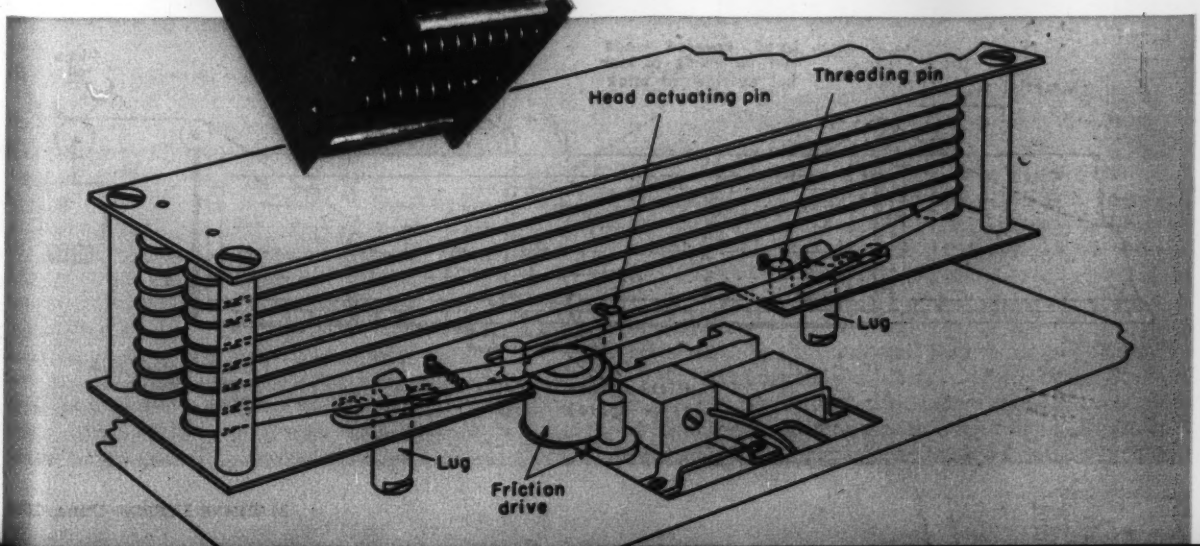
Self-threading endless tape magazine, right, for playback machines designed by Powell Announcer Corp. facilitates the changing of recorded messages without the operator touching the magnetic tape itself. The magazine is a moving storage and the tape is wound continuously around four rollers. Each roller has four spools for travel of the tape. It climbs up one pair of rollers and then descends down the other set so that it passes on a direct line through the magnetic pickup of the machine.

Features of the threading mechanism are indicated in the drawings. When the magazine is inserted in the playback machine, two lugs enter elongated holes in the bottom plate of the magazine. Slots at the bottom of the lugs allow the magazine to be shifted sideways when the plate reaches the slots. Arms carrying the threading pins are retracted by the movement of the lugs, threading the tape into position in the magnetic head. At the same time, a head actuating pin, moved by a central slot in the bottom plate of the magazine, closes the head mechanism and brings the friction drive roller into contact with the tape. In this way manual

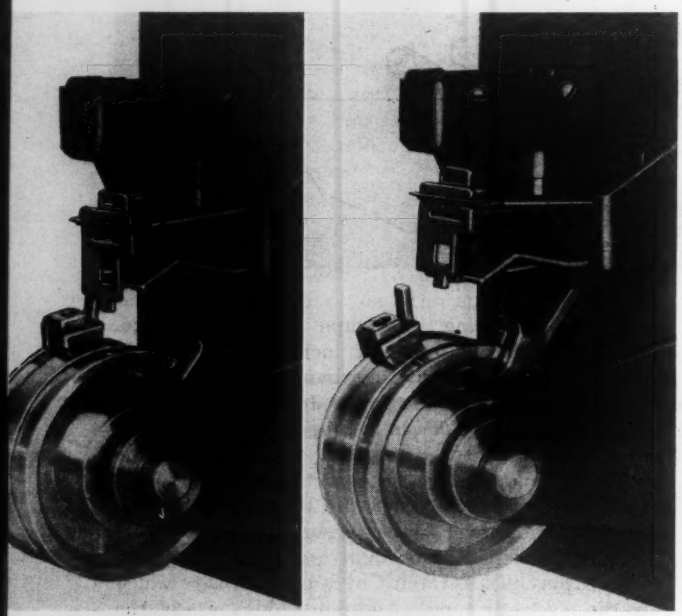


threading is obviated, protecting the tape against damage.

Standard speed of seven and one-half inches per second is employed for the magnetic tape. Drive mechanism consists of a 1/70-horsepower motor runing at 1740 rpm to drive a flywheel by friction. Top of the flywheel shaft drives the tape when a neoprene idler roller is forced against it. A three-tube amplifier, mounted in the same case with the drive, uses standard tubes and parts. In its present form the player unit is designed to start operating when a phototube light beam is interrupted. End of play is determined by a piece of tape glued on the magnetic tape. Additional thickness of the tape triggers a precision switch, stopping the machine until the next cycle is initiated.



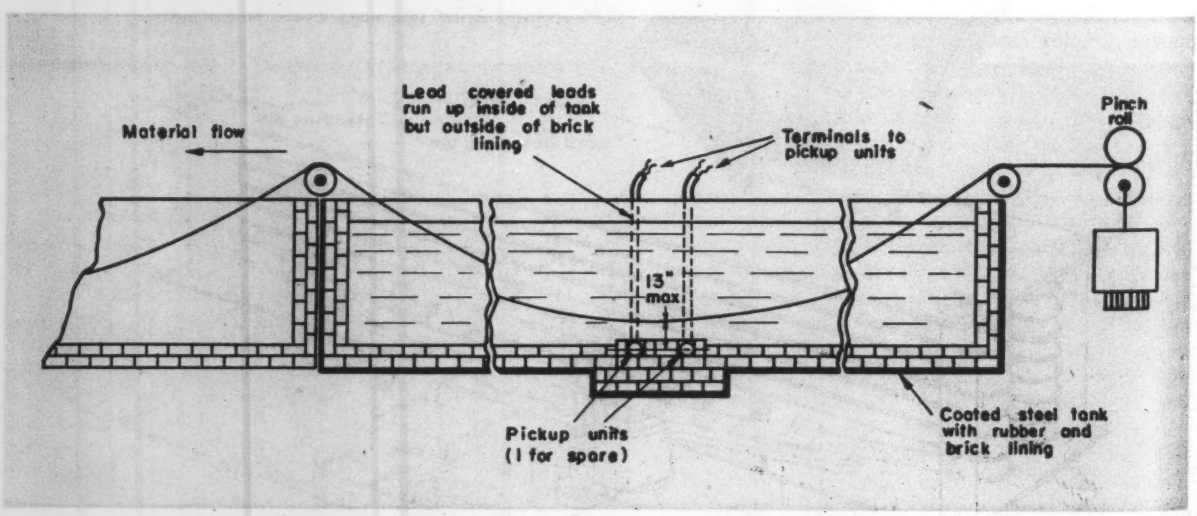
Latch mechanism, below, for operating precision switches in Taylor Instrument Co. timers is readily adjustable both as to time and to duration of operation. A short cam on a rotating drum operates the switch by tripping a flapper on the latch, allowing the mechanism to spring upward and depress the switch plunger. When the long cam contacts the assembly it relatches the flapper so that, when the cam has passed, the latch returns to position, releasing the switch until the cam trips the latch again.



Magnetic loop control regulator, illustrated below, maintains accurate position of 66-inch wide strip travelling through pickling tanks at 500 fpm. Proximity of the catenary loop to magnetic pickup unit in the bottom of the tank affects the control current flowing through the pickup, adjusting the speed of tension pinch rolls so that the length of loop remains constant regardless of changes in speed of the strip.

Heretofore, the position of the loop has been controlled by a rheostat coupled to a dancer roll which rides the loop position at all times. Being too slow for high-speed operations and requiring excessive maintenance, the dancer roll system could not produce consistent quality, particularly during acceleration and deceleration periods. To overcome these disadvantages the General Electric Co. developed the magnetic type of pickup unit for location in the bottom of the pickling tank. The output of the unit is inversely proportional to the distance between the unit and the strip, thus providing a control current for regulating the pinch rolls which determine the position of the strip loop.

Consisting of a bundle of steel laminations wound with three separate coils, the pickup unit has two coils to form a long closed magnetic core and the third to form an open ended magnetic core. The two coils are excited from an alternating-current source, their impedance varying with the degree of saturation of the laminated core, and supply the control current. Saturation is controlled by flux from the third coil excited by its direct-current source. This flux produced by the direct-current winding is practically all leakage flux and, therefore, is greatly influenced by the close proximity of the loop of strip steel. The system is adjusted so that the loop is close to the bottom of the tank but does not touch it.


Material flow
Lead covered leads run up inside of tank but outside of brick lining
Terminals to pickup units
Pinch roll
13" max
Pickup units (1 for spare)
Coated steel tank with rubber and brick lining

Why Machine Parts Fail

Part 2–Origin and Growth of Cracks

By Charles Lipson
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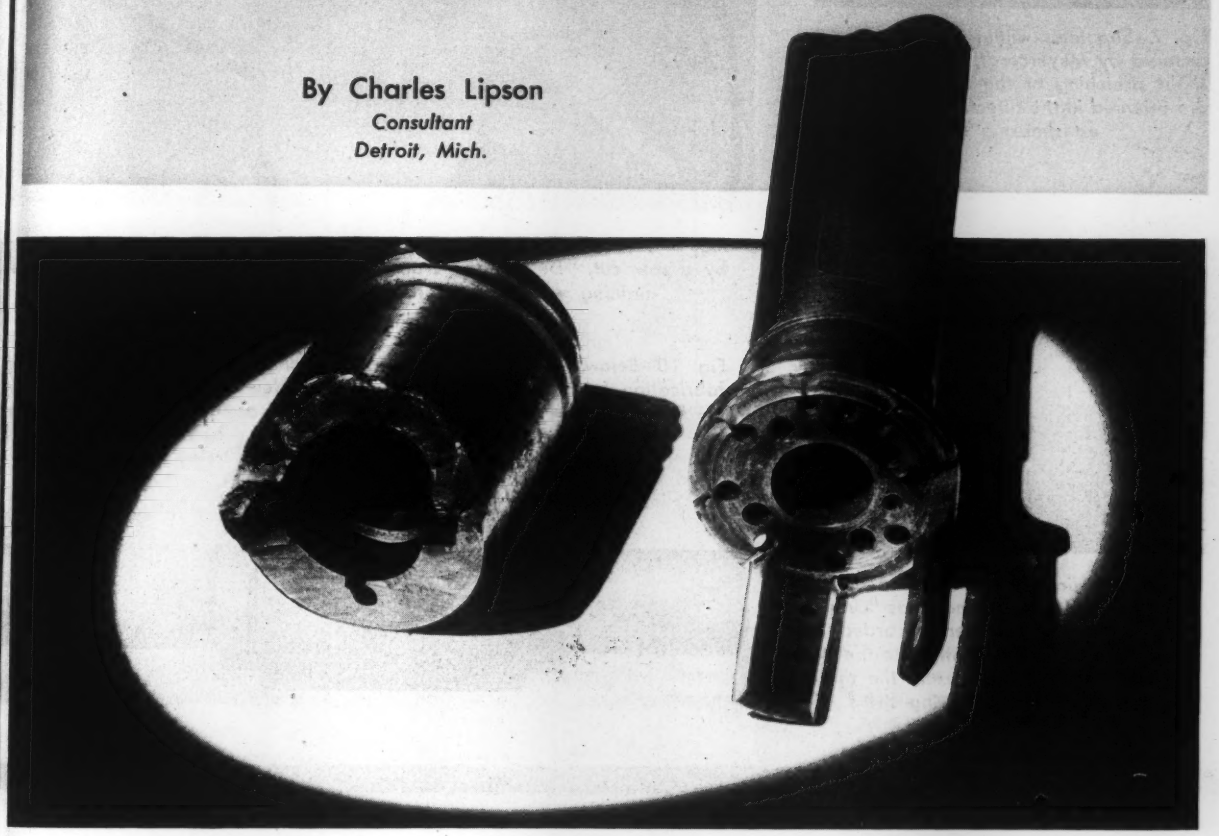


Photo, courtesy Chicago Pneumatic Tool Co.

MANY theories have been advanced as to how a metal part fails when subjected to loads. Some of them were not consistent with new facts observed in experimental work and had to be discarded. Several others are either consistent with known facts or have not been refuted by them and appear to offer satisfactory explanations of failure phenomena. There are four principal theories of failure: (1) the slip theory, (2) the internal flaw theory, (3) the external flaw theory, and (4) the dislocation theory. Of these the slip theory is the most applicable, and will be discussed here.

It is clear that during the fatigue process some effect takes place which initiates a minute crack or increases the size of an already existing one. A condition of stress causes the crack to spread until gross failure occurs across the entire section of the part.

The slip theory holds that the primary cause of all fatigue cracks in otherwise sound metal is slip on the crystalline level. This belief is generally held and is supported by considerable experimental evidence. Intracrystalline slipping is an indication that the metal at that place has passed its yield point and is manifested by the appearance of fine parallel lines (microscopic order of size) on the face of crystal grains. These lines are known as *slip-lines* and are shown in *Fig.* 7. Intercrystalline slipping which occurs on a gross scale when the metal is yielding also gives rise to fine parallel lines known as *Luder's lines*[1] on the surface of the metal as shown in *Fig.* 8. The similarity of slipping on a microscopic level to plastic flow on

[1] References are tabulated at end of article.

Fig. 7—Slip lines within a crystal grain, pictured by Meyercordt, were formed by slight stretching of the steel rod. Lines are oriented in the direction of the greatest shearing stress

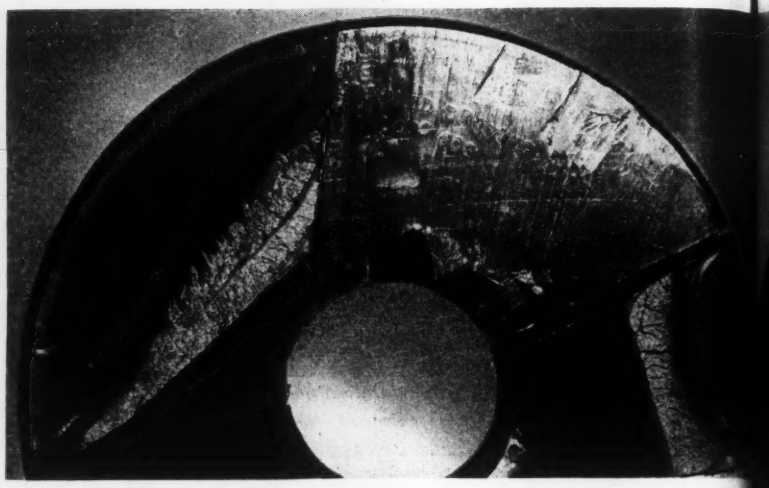


Fig. 9—Above—Two fatigue cracks in this locomotive axle were expos by a saw cut. Despite the cracks, the large amount of sound metal r maining would permit the axle to withstand normal loads

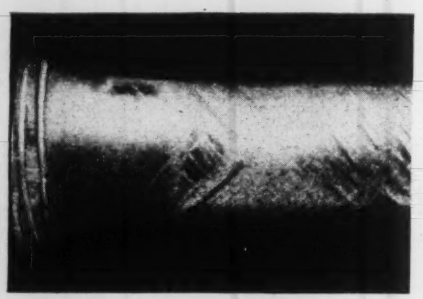
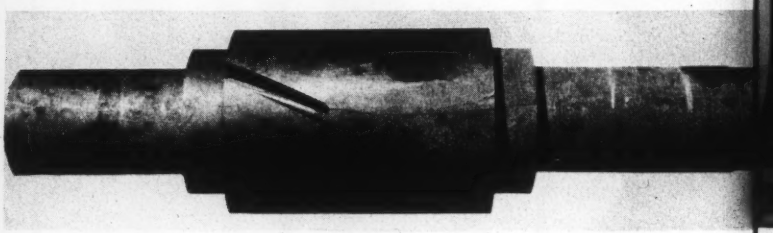


Fig. 8—Slip lines on the surface of this stretched steel rod are known as "Luder's lines." On this specimen, recorded by Ewald, Poschl, and Prandtl, note the 45-degree orientation of lines in the direction of greatest shearing stress

Fig. 10—Below—The crack in this rolling-mill drive pinion occurred durin fabrication because of high residual stress due to improper treatment the forging. However, crack propagation was abetted by the presence numerous ruptures in the center of the forging as shown in Fig. 11

Photo, courtesy Republic Steel



a macroscopic level gives rise to the belief that the two phenomena are closely associated.

It has frequently been found that a fatigue crack follows the direction of a slip line, and therefore it is considered probable that the origin of fatigue cracks is to be found in the minute discontinuities produced by granular slip lines.[2]

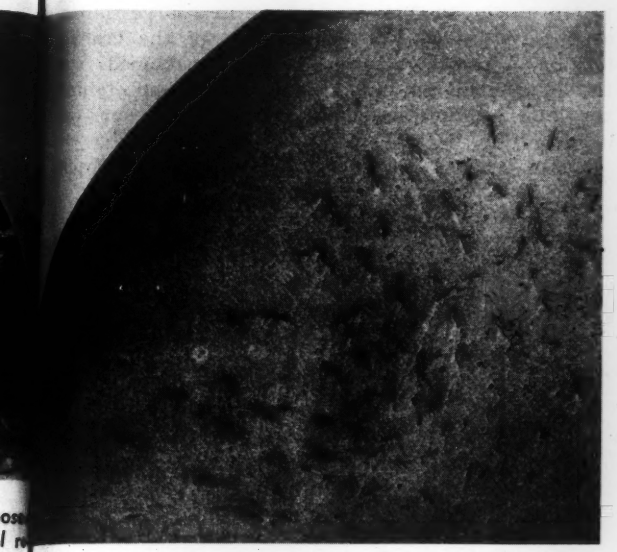
Three Initial Stages Mark Crack Origin

According to the slip theory fatigue behavior may be summarized in three stages:

1. No damage is observed microscopically
2. Slip line formation takes place with gradual broadening of these lines
3. The crack sets in, most frequently at site of marked slip

Ultimate failure results from further extension of the initial crack, and it is this intermediary phase which will now be considered. Data on the growth rate of cracks characteristic of different steels have made it possible to locate fatigue cracks by periodic inspection before failure sets in. If the cracked part is large, it may stand up a long time under service. For example, in steamships when a heavy sea destroys the propeller's bite, the subsequent racing of the propeller may cause overloading sufficient to initiate a crack in the tail shaft. However, the shaft may not fail for a considerable time if the normal operating stresses are negligible compared to the stresses which originated the cracks.

An outstanding example of detection of fatigue cracks prior to actual failure of the part is illustrated in *Fig.* 9. The cracks in this locomotive axle were detected with the Sperry Reflectoscope in which ultrasonic waves are reflected from any internal discontinuities within the piece being tested. This shaft ran many miles and withstood thousands of cycles of stress before the fatigue cracks progressed to the extent shown. From cases in which such shafts actually failed in fatigue, it is known that these failures can occur after as many as a million miles of service. It is quite probable that the cracks in this case were initiated by a few brief intervals of high over-



Photo, courtesy Republic Steel Corp.

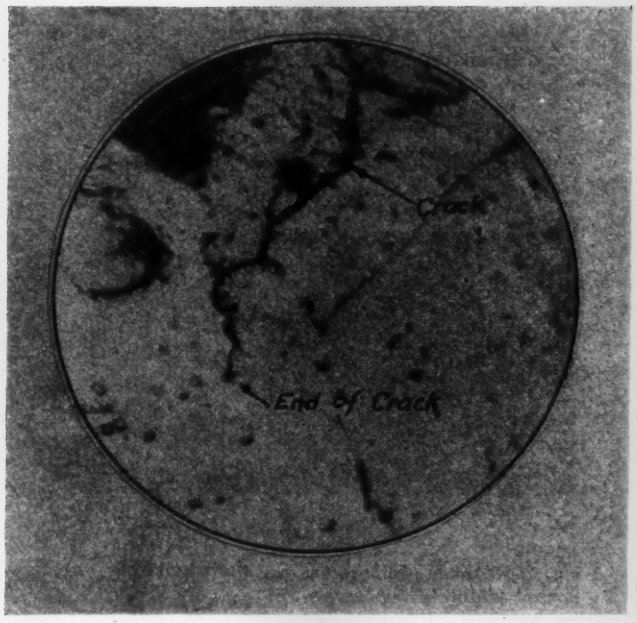


Fig. 11—Left, above—Internal ruptures are shown by this section of the forging pictured in Fig. 10. These discontinuities were responsible for the more rapid advance of a crack initiated by the residual stress near the outer fibers

Fig. 13—Above—Photomicrograph by Moore and Kommers, shows a fatigue crack with rounded end. Magnified 3560 diameters

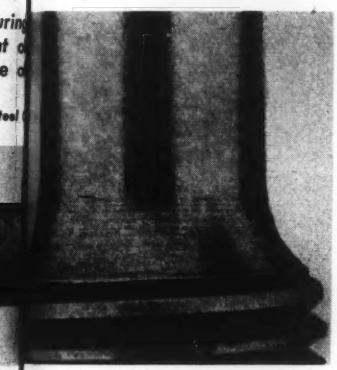


Fig 12—Left—Rotary bending caused the fatigue cracks in this specimen investigated by Bacon. Cracks were visible only after tension was applied following fatigue tests

load. Since normal operating stresses were relatively low and the shaft quite large in diameter, the fatigue cracks remained essentially dormant until the next period of overload which might not have occurred for a thousand miles. Actually, this shaft which has been opened at the plane of the crack by a saw cut might have been used for thousands of additional miles if kept under observation.

Endurance Limit Not Enough

FATIGUE STRENGTH: The inception of a fatigue crack is not in all cases as important as the propagation of the crack. Furthermore, parts rarely fail from simple cyclic overloading but rather from the concentrating of this load by geometric and other discontinuities. Hence, it becomes apparent that endurance limit is not the only factor in determining the relative merits of different steels. A fatigue crack is in itself a stress raiser and the inherent property of a metal to *resist* various forms of stress raisers will classify the material according to ability to retard propagation of cracks. There are, therefore, three factors defining the fatigue strength of metals:

1. Strength of unnotched material (the so-called endurance limit)
2. Strength under a finite mechanical notch (this factor involves both the true notch sensitivity of the metal and the degree of sharpness of the notch)
3. Resistance to fatigue crack spreading.

Although the endurance limit of various materials and its values with varying properties of the material are well known, the notch sensitivity of common engineering materials has not yet been fully explored. Two values of particular importance to notch sensitivity may require determination:

1. *Maximum stress* at which a fatigue crack will *not* propagate
2. *Rate* at which a given crack will propagate.

Obviously, once a crack is formed its rate of advance depends upon several factors:

1. Intensity of Stress
   a. Shape of specimen—stress magnitude

b. Presence of crack—stress concentration
c. Size of part—stress gradient

2. Strength of Material
a. Endurance limit
b. Quality of material, flaws, inclusions, etc.
c. Notch sensitivity.

An example of the effect of unsound steel is illustrated in *Fig.* 10. This is a failure in a large rolling-mill drive pinion. For examination of the cracked forging, a transverse test slice was machined from the 23-in. diameter pinion body. After deep etching, the internal ruptures shown in *Fig.* 11 became evident.

CRACK ADVANCE: The basic work on fatigue cracks

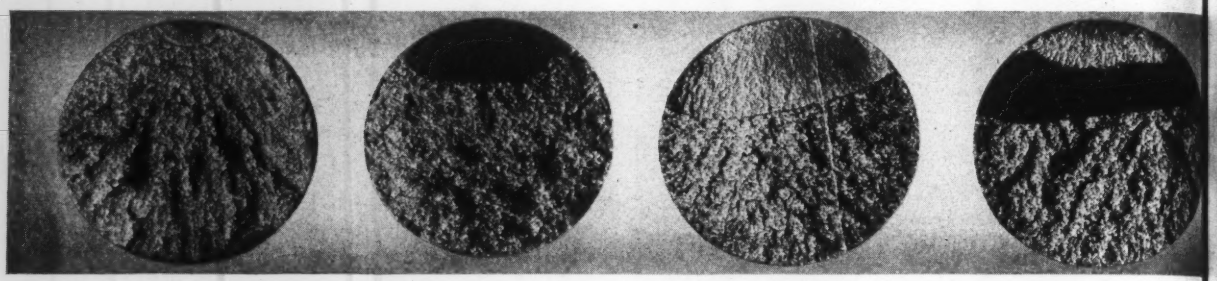


Fig. 14—Above—This series by Bacon illustrates progress of fracture through a medium carbon steel specimen

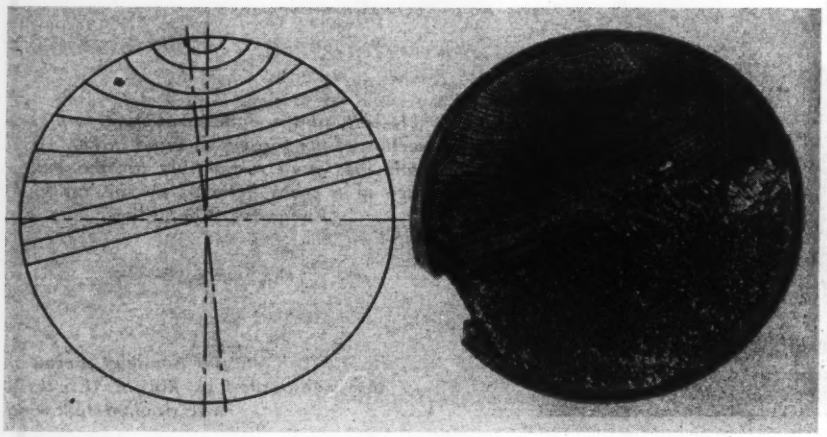


Fig. 15 — Right — Agreement of hypothetical fatigue growth, left, with actual failure, right, is strikingly illustrated by Bacon

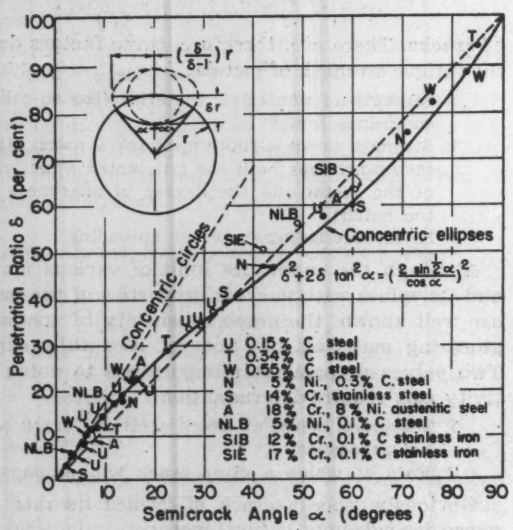
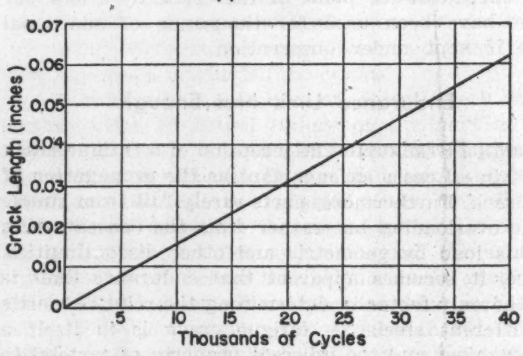

Penetration Ratio δ (per cent)
Semicrack Angle α (degrees)
Concentric circles
Concentric ellipses
$\delta^2+2\delta \tan^2\alpha = \left(\frac{2 \sin \frac{\pi}{2}\alpha}{\cos \alpha}\right)^2$
U 0.15% C steel
T 0.34% C steel
W 0.55% C steel
N 5% Ni., 0.3% C. steel
S 14% Cr. stainless steel
A 18% Cr., 8% Ni. austenitic steel
NLB 5% Ni., 0.1% C steel
SIB 12% Cr., 0.1% C stainless iron
SIE 17% Cr., 0.1% C stainless iron

Fig. 16 — Left — Hypothetical relationship between crack penetration and crack angle in rotary bending correlates well with actual data for many different types of metals

Fig. 17—Below—In the initial stages, crack growth is directly proportional to the number of stress applications



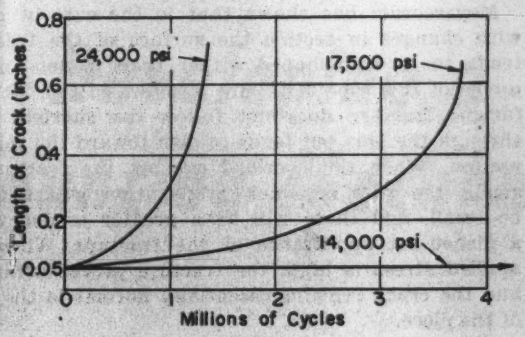


Fig. 18—Fatigue testing of cracked specimens, reported by Moore, showed that a stress of 14,000 psi would not spread the crack. More highly stressed samples failed quickly

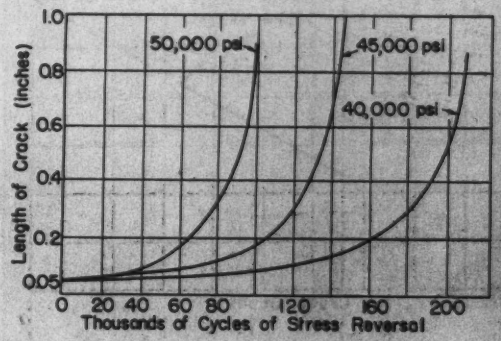


Fig. 19—This study by DeForest of fatigue crack propagation for SAE 1020 steel rod holds for all surface conditions. Note that when the crack reaches an appreciable length for each load, most of the life of the part is gone

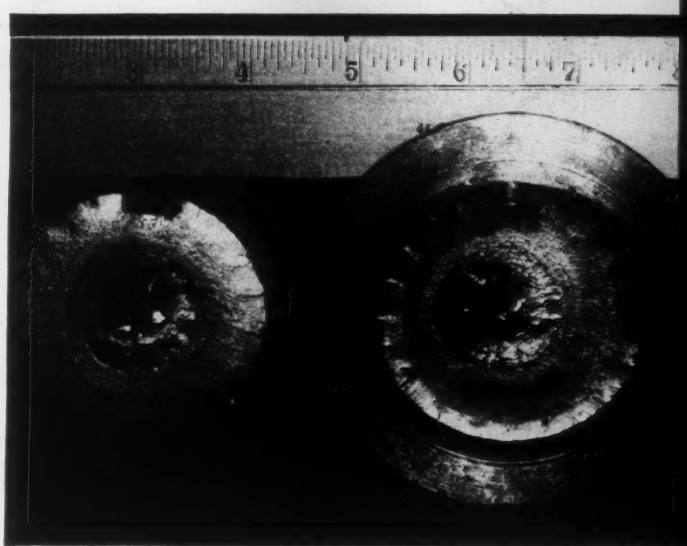
was done by Prof. Bacon in England[3]. His technique involved fatiguing a specimen until a crack developed and subsequently breaking it in a regular tension test. *Fig.* 12 shows a fatigue crack that could not be detected microscopically but was visible after the specimen was stretched in tension, *Fig.* 13 is a photomicrograph of a fatigue crack in Armco iron under a high magnification. It will be noted that the crack has a rounded end[4].

Heat Tint Method Shows Crack Growth

To study the progress of a fatigue crack, Bacon developed the *heat tint* method. This consisted of stopping the test when it was suspected that a fatigue crack had been formed and placing the specimen in a furnace with an oxidizing atmosphere at 250C. When the part had cooled, the fatigue test was resumed. From the different discolorations, as shown in *Fig.* 14, he then plotted the progress of the fatigue crack. As can be seen from *Fig.* 15, there is a remarkable similarity between the hypothetical crack growth and the actual fracture. *Fig.* 16 shows the correlation between crack angle and crack depth[5], a correlation which apparently holds for many different types of metals.

Relationship between the applied stress and the rate of crack growth is illustrated in *Fig.* 17. In the initial stages crack growth is directly proportional to the number of stress applications. *Figs.* 18 and 19 illustrate the effect of increasing applied stresses on crack propagation from the initiation of the crack to gross fracture.

It has also been noted that if, after the fatigue crack has formed, the stress is reduced appreciably below the value necessary to initiate it, the crack may not propagate itself any further, as shown in *Fig.* 18. This may be due to the strengthening effect of this low stress which will tend to round off the end of the crack. As noted earlier, resistance to the spread of the crack will probably vary with different



Photo, courtesy Armco Steel Corp.

Fig. 20—In this dish-shaped fracture the dishing is toward the heavier section because of the distortion of the stress field at the change of section

Fig. 21—Change of section and presence of crack influence the direction of stress lines. This diagram by Meyercordt shows how a fatigue crack advances in a direction normal to the stress lines and leads to a dish-shaped fracture

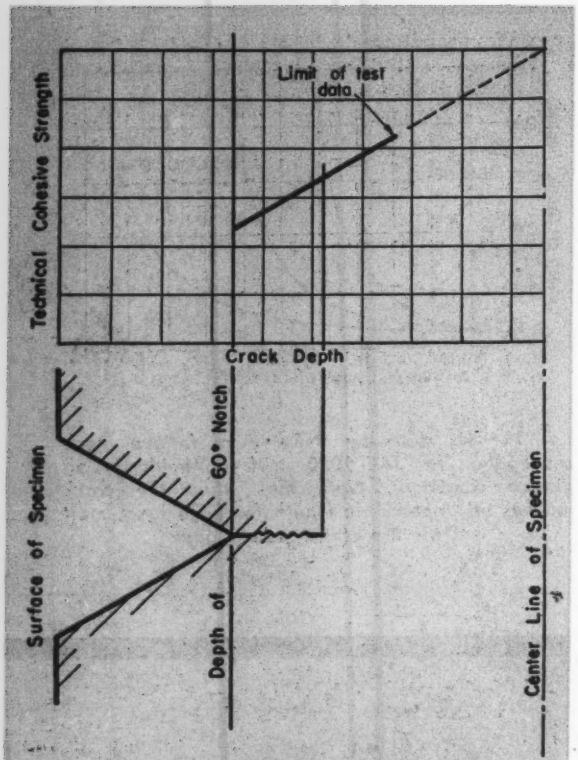
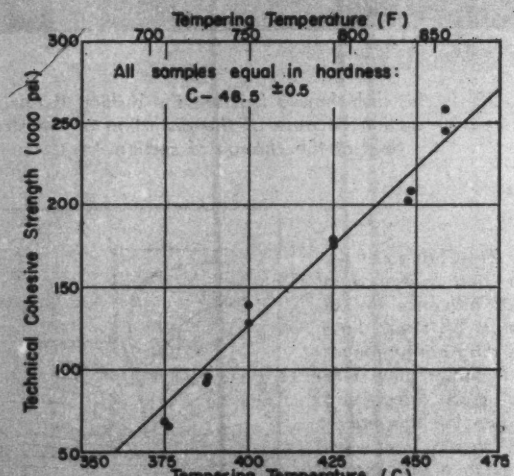


Fig. 22—Above—Unit stress required for final rupture increases with crack depth. Adapted from a study by Gensamer, this diagram shows how the ultimate value of technical cohesive strength is obtained by extrapolation to the center line (zero remaining area of sound metal)

Fig. 23—Below—As shown by Gensamer, the cohesive strength varies widely even though hardness is constant, depending on time and temperature of the tempering after quenching



materials, heat treatments, etc., and is to be considered a fundamental property of the metal.

Meyercordt[6] has shown that in the case of parts with changes in section the surface of the fracture tends to be dish-shaped rather than plane. An example of this type of failure is shown in *Fig.* 20. The fatigue fracture does not follow the shortest path through the part but tends to dish toward the thicker section. When the overload causing the fracture is small, the rate of crack propagation will likewise be small, and there will be a greater tendency for a dished-out appearance of the fracture. When the applied stress is high, the fracture proceeds rapidly and the crack remains essentially normal to the axis of the piece.

Stress Reorientation Influences Crack Direction

A reasonable explanation of this condition is shown in *Fig.* 21. The change of section and the presence of the crack both alter the orientation of the tension stress field. The direction that the crack takes is not exactly in the direction normal to the original stress field but deviates from it somewhat by propagating normally to the new field as fast as it is created.

FINAL RUPTURE: At what level of stress does final rupture take place? According to Gensamer[7] in the case of a notched specimen the nominal stress (load divided by the area of cross section) required to cause fracture increases with the sharpness of the notch while plastic deformation preceding fracture decreases. As the depth and sharpness of the notch increase, the yield strength and tensile strength at fracture tend to become equal. This stress level is called the *technical cohesive strength* and is the nominal stress causing crack propagation when the notch is both sharp and deep. *Fig.* 22 illustrates the effect of depth of crack on cohesive strength. The relationship found within the test range of crack depth can be extrapolated to the center line. This value for zero remaining area of sound metal indicates the stress magnitude required to propagate a crack suddenly to ultimate fracture in the particular material tested.

As *Fig.* 23 shows, cohesive strength varies widely even though hardness is constant, depending on time and temperature of tempering after quenching. It is clear, therefore, that the ability to resist crack propagation results from conditions of tempering, and is an inherent property of the material.

In the next article of this series the two basic types of failure likely to occur in service will be discussed.

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Developing a Counting Mechanism

... for high-speed calculating machine

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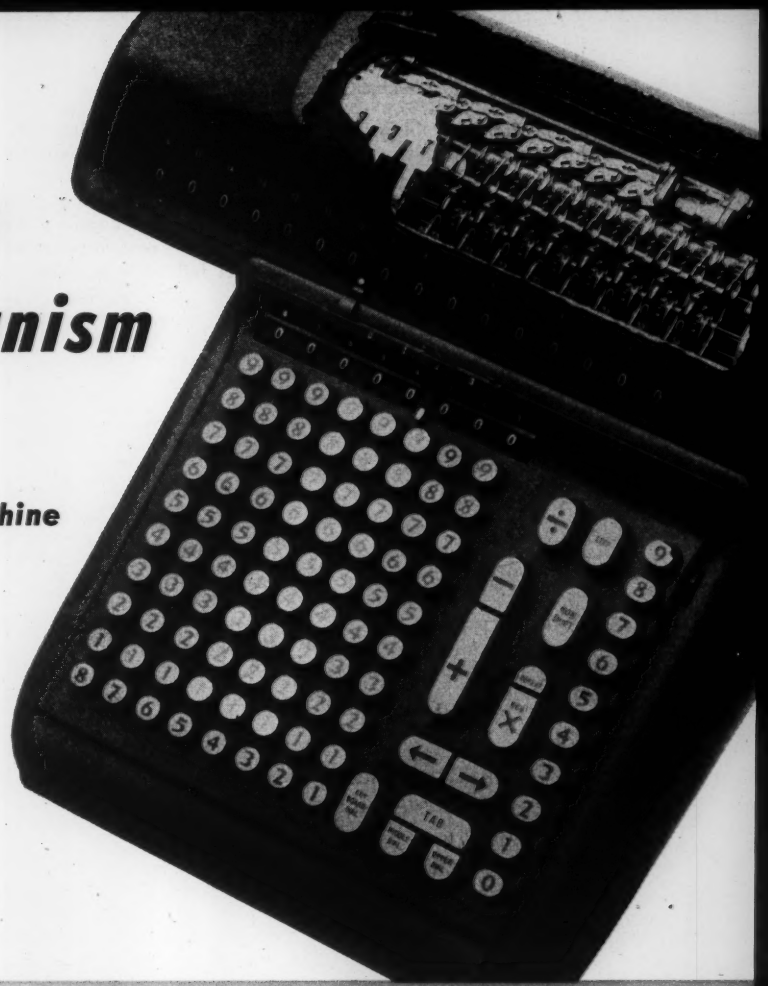


DEVELOPMENT of mechanisms capable of operating dependably and quietly at high speed is primarily responsible for the improved performance of the modern calculator. Although the design of such a machine is much the same as that of other high-speed mechanisms, economic considerations and space limitations account for certain important differences.

Because of the multiplicity of parts, cost of unit parts must be kept to a minimum. This precludes the use of high-precision finishing methods or the use of antifriction bearings to any great extent. As a result the designer must give careful attention to operating surfaces and must work with friction coefficients as high as 0.25, depending primarily upon case hardening to provide necessary service life. Furthermore, weights of fast-moving parts and assemblies must be controlled in order to minimize effects of high accelerations and decelerations.

Multiplicity of parts also restricts the designer's choice of mechanisms to those that can be fitted into the small available space. This factor is particularly restrictive when a new unit is to be fitted into a machine already in production.

Fig. 1—Above—Cutaway view of new Marchant Figuremaster calculating machine shows the high-speed, continuously readable counting mechanism

COUNTING REGISTER REQUIREMENTS: A calculating machine designed for performance of multiplication and division includes a counting register to count the number of cycles of machine operation in each decimal position. This count constitutes the multiplier, in multiplication, and the quotient in division.

In division problem operation, there is a time interval after the introduction of the automatic operation when the machine completes the quotient, order by order, from left to right. During this period operators working with the older type of machines frequently would start to write down the quotient digits as fast as they appeared on the register. On the first calculator introduced to operate at 1350 cycles per minute, in contrast to 700 cpm, this continuous readability was not provided because the higher operating speed reduced the time saved by this feature.

For newer Marchant models, however, a counting

Fig. 2—Right—In this original overthrow-proof counter actuator, path of counting finger tip is controlled by combined effect of eccentric, kidney slot and finger slot. Tip enters tooth space along upper path; moves down, driving gear one tooth interval; retracts along lower path, stopping the following tooth near its full cycle position. A centralizer pawl, shown in Fig. 3, holds the gear in full cycle position

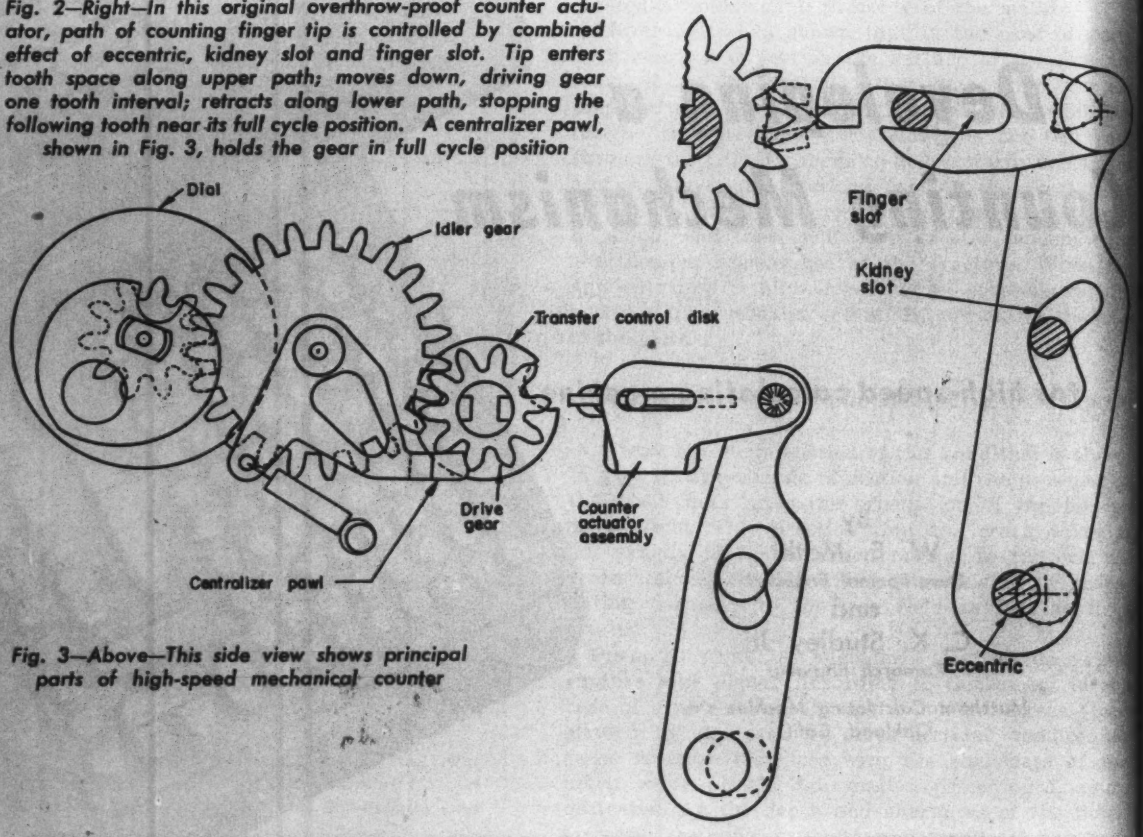


Fig. 3—Above—This side view shows principal parts of high-speed mechanical counter

register has been developed that combines high-speed operation with the continuous readability of the older types. The new counting mechanism, exposed in *Fig.* 1, presented a series of challenging design problems. How these difficulties were analyzed and overcome will be explained in this article.

APPROACH TO THE SOLUTION: Actuation of the counter in all portable calculators is intermittent. The driving element engages the register dial gear train for only part of the machine cycle. Use of this type of drive very conveniently permits shift of the carriage during the time when the dial gear train is not engaged. However, with this intermittent drive the dial gear train is "on its own" rotationally when the driving element has disengaged, and is therefore susceptible to overthrow—rotation of more than the required one digit per cycle. Hazard of overthrow has kept the speed of most commercial models of this type of mechanism below 700 cpm.

When the earlier high-speed calculator was first developed, an overthrow-proof counter actuator* was designed to permit a counting speed of 1350 cpm. It employed a single ordinal actuating element that reduced the residual rotational velocity of the dial train at the end of each digital step of movement.

Retaining this high-speed safety for the multi-ordinal actuator of the new continuously readable counter introduced numerous problems. Importance of effective material distribution and careful design of pivots and operating surfaces to achieve accuracy of movement of the high-speed selectively operated elements will be apparent from the following description.

ORIGINAL COUNTER ACTUATOR: In the actuator of the first model of this new type of counter, one counting finger unit of the type shown in *Fig.* 2 was provided for each dial order. A series of such units was mounted on a common shaft pivoted for eccentric rotation. As shown in *Fig.* 3, effect of the actuator upon the drive gear was transmitted by an idler to a gear riveted to the dial shell. The centralizer pawl maintained the drive gear in full cycle position, the dial in full digit position.

How adjacent actuator mechanisms of the orginal model operated with each other is shown in *Fig.* 4*a*. To permit the actuation of the dial order to be selectively disabled, the kidney slot was relieved on the left side and the actuating link was spring-urged leftward against the guide shaft. An ordinal transfer control disk, associated with the gear of the corresponding ordinal dial train, was engaged by a roller mounted on the transfer finger for the next higher order and thus normally prevented actuation of that order. However, when the dial in the lower ordinal position would stand at nine during plus counting, or at zero during minus counting, the tens-carry operation in the higher order occurred. This

* Avery Patent 2,267,890.

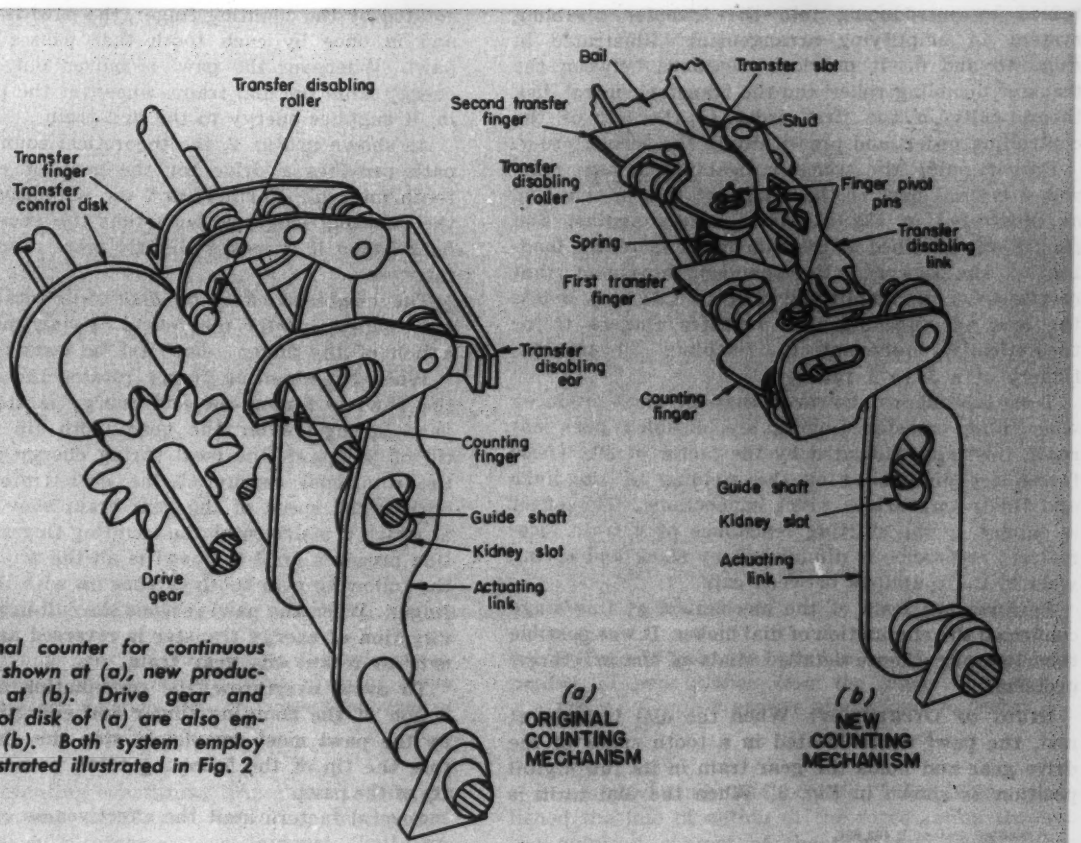


Fig. 4—Original counter for continuous readability is shown at (a), new production counter at (b). Drive gear and transfer control disk of (a) are also employed with (b). Both system employ principle illustrated illustrated in Fig. 2

action was allowed by entry of the transfer disabling roller into the single notch of the transfer control disk.

Transfer movement of higher order dials was made subject to the simultaneous actuation of all lower order dials to and including the counting order. An ear provided on each transfer element prevented each transfer finger from moving into the dial drive gear farther than the counting or transfer finger to its right.

Correct actuation of a dial order requires that the counting finger conform to the path of movement shown in *Fig.* 2. If engagement depth is appreciably reduced, overthrow, or in the extreme, complete failure to actuate will result. On the other hand, dial flicker may result if the transfer disabling system does not prevent contact between the disabled transfer fingers and their dial gear train elements. The most dangerous situation in this respect arises when the rightmost order is preventing a transfer in all orders to the left, such as when the dials read 99999996 in plus operation. In this case the roller on each transfer finger is passing the corner of the notch in the transfer disk once each cycle. If engagement of the roller with the corner of the control disk exceeds a certain amount, dial flicker will result.

In the first model counter, *Fig.* 4*a*, the disabling ears did not adequately resist dynamic effects of sudden accelerations and decelerations that occur in the operation of the transfer fingers. It was impossible to disable the transfer fingers effectively to avoid dial flicker and at the same time permit sufficient engagement to prevent overthrow in any except the first and second orders to the left of the disabling order.

NEW COUNTER ACTUATOR: Dial train actuation of the final model, illustrated in *Figs.* 4*b* and 5, is effected by the tips of the counter and transfer fingers, both mounted on the bail by means of finger pivot pins. A spring holds the fingers counterclockwise against the front of the bail in actuating position. The entire bail assembly is positively driven by an eccentric system and the finger tips follow the typical Avery path, *Fig.* 2.

Disabling of counting fingers is produced by the blocking of the roller against the control disk and is sustained to the left from order to order by the disabling links. The stud in the left end of the disabling link slides in the transfer slot to prevent left to right disabling.

For this actuating mechanism, weight of the yieldable transfer finger has been reduced and at the same time effective strength of the transfer disabling system has been increased. Each of these items has contributed to improvement of the control of the transfer fingers with a resultant reduction in overthrow and dial-flicker tendencies.

Additional safety against dial flicker has been at-

tained by introducing into the transfer disabling system an amplifying arrangement* illustrated in *Figs.* 4*b* and 6. It provides clearance between the transfer disabling roller and the transfer control disk theoretically in the first order to the left of the controlling order, and practically in the second order.

Proportioning the transfer disabling linkage ratio was a critical part of the design of this mechanism, as illustrated in *Fig.* 6. Extra safety against dial flicker was obtained at the expense of increased loading of the linkage. Compounded movement that results from the amplifying ratio of 1.23 to 1 causes the load of disabling nine transfer fingers to be theoretically equivalent to disabling 30 transfer fingers at a 1 to 1 ratio.

Tests have shown, however, that the force produced when nine transfer fingers are disabled does not reach the value indicated by the factor of 30. These forces are diminished by the yielding of the links and floats on various pivot connections. The effect is similar to the starting resistance of a train locomotive; resistance is diminished by slack and spring yield in the couplings between cars.

Performance tests of the mechanism at this stage confirmed the elimination of dial flicker. It was possible then to make a more detailed study of the overthrow problem.

STUDY OF OVERTHROW: When the dial train is at rest, the pawl tip is located in a tooth space of the drive gear and holds the gear train in its full digital position as shown in *Fig.* 3. When the dial train is rotated by the counting finger, the pawl is moved out and in once by each tooth that passes under the pawl. Whenever the pawl is moved out, it absorbs energy from the dial train; whenever the pawl moves in, it supplies energy to the dial train.

As shown in *Fig.* 2, the theoretical counting finger path provides a drive for the gear of exactly one tooth interval. Furthermore, the withdrawal path of the counting finger is such that the gear train will be arrested if it moves slightly more than one tooth interval.

The combined effect on dial train rotation of the pawl action and the theoretical driving and arresting action of the finger must first be considered.

When the counting finger rotates the drive gear, the pawl is forced out and energy is stored in the pawl spring. After the gear tooth tip passes the tip of the pawl, the pawl spring energy is added to the rotational energy of the gear train. This increases the speed of the gear train above the speed at which it is driven by the counting finger. Acceleration proceeds until the pawl is all the way in or until the following gear tooth catches up with the counting finger. When the pawl reaches the full-in position the direction of energy transfer is reversed and the pawl acts to retard the gear train.

To avoid overthrow, the combination of arresting action of the counting finger and energy absorption by the pawl must completely stop the dial train before the tip of the following tooth passes under the tip of the pawl.

Several factors limit the effectiveness of these two

* Studley Patent 2,462,690.

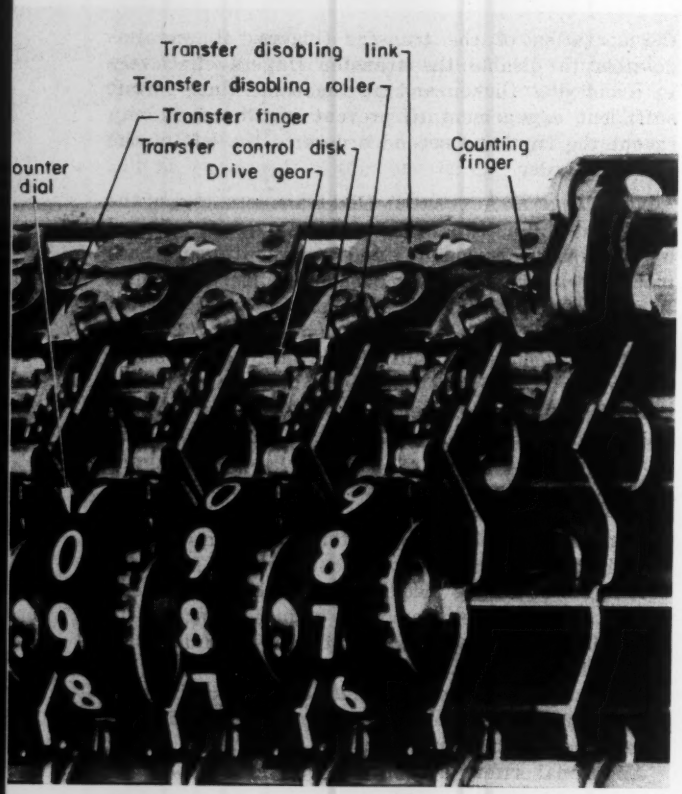
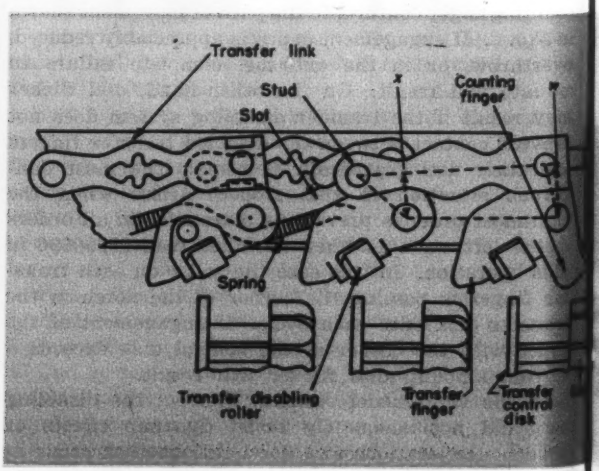


Fig. 5—Left—Partial view of the calculator shows arrangement of parts in the new counting mechanism located in the shiftable carriage of the machine

Fig. 6—Below—Ratio of effective moment arms (w) and (x) for controlling and disabled fingers, respectively, causes disabled finger to move faster initially and rock farther than controlling finger. Adequate safety against flicker is obtained without excessive rock of fingers near left end of bail



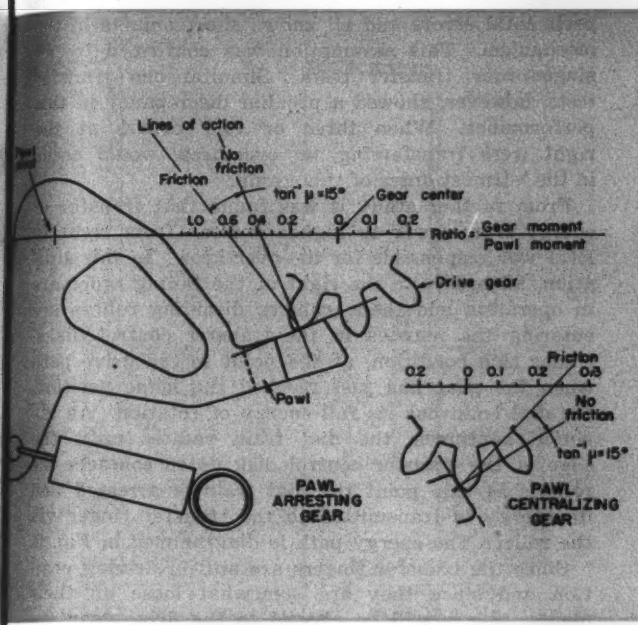


Fig. 7—Pawl and gear moments are graphically determined by means of this layout. Scale divisions along line of centers aid determination of moment-ratio values

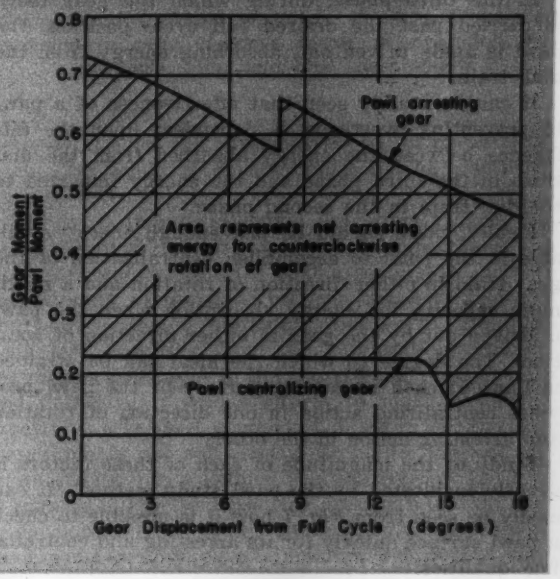


Fig. 8—Ratio of gear and pawl moments versus angular position of gear plotted from the layout illustrated in Fig. 7. Graph areas are proportional to energy

items in preventing overthrow. These restrictions are inherent in the multiorder actuating mechanism. They include such things as pivot looseness, bail flexibility, and inaccuracies of various duplicate parts, each of which must co-operate with another group of duplicate parts.

One of the chief troubles is misalignment of drive gears and counting fingers. This condition reduces effectiveness of the counting fingers and the centralizer pawl in controlling dial train movement. Safety against overthrow is diminished when the drive action of the transfer finger continues beyond the centralized position for two reasons: it counteracts the arresting action of the centralizer pawl which should be effective at this point; and the arresting retrograde movement of the transfer finger is likewise displaced and will have less time to act on the dial train before the overthrow point has been reached.

Incorrect alignment may also increase the possibility that energy, which is absorbed by a transfer lever in one dial order, will be fed back into the dial train in the next higher order. The existence of such a feed back was discovered by correlation of an appraisal of the pawl properties with observed performance. This study included determination of the residual velocity of the gear train—the velocity that would be reached if the transfer finger offered no resistance. Obtained graphically from a precision layout of the mechanism, residual velocity was combined with calculated inertia of the dial train to obtain the residual rotational energy of the dial train.

The energy absorption properties of the pawl were obtained by employing a graphical method originated by Dr. G. V. Nolde, consultant on the engineering staff of the Marchant Calculating Machine Co.

In his pawl study method, *Fig.* 7, Dr. Nolde established the line of action of the force acting through the point of contact of the pawl and gear. When friction is neglected, the line of action is normal to the surfaces. To include the effect of friction at the contact point, he offset the line of action in the direction of the friction component by the amount of the friction angle, μ, about 15 degrees in this work. He then demonstrated that in a transfer of energy between pawl and gear the ratio of their moments is proportional to the distances from the respective pivots to the intersection of their line of centers with the line of action of the force. He further showed that it was possible, using this relationship, to study conveniently the forces and energy involved in the interaction of pawl and gear.

As will be described, the ratio of gear moment to pawl moment was used together with the moment produced by the pawl spring to obtain the moment applied to the gear.

The energy represented was then determined by graphically integrating the resultant gear moment for the angle through which the gear moves.

Whenever the dial train is rotated by the counting finger, the pawl is moved out and in once by each tooth that passes under it. When the pawl moves out it stores energy, and when it moves in it returns energy to the gear train. In a study of the operation of the pawl in controlling overthrow, the first outward movement of the pawl is not important since the pawl is entirely overcome by the counting finger.

The second phase, wherein the pawl returns stored energy to the dial train, is important since this transfer of energy and the resultant increase in speed of the dial train cannot be prevented by the counting

finger because of backlash between finger and gear.

In the third phase, during which the gear tooth is carried past the desired full cycle position, the pawl is again driven out, absorbing energy from the dial train.

It can be readily seen that effectiveness of a pawl in preventing overthrow is dependent upon the difference between the energy absorbed from the dial train in the third phase and the energy imparted to the dial train in the second phase.

Ideally, there should be just enough energy available in the pawl to accomplish centralization of the gear train in either direction of rotation and a maximum capacity for energy absorption when the pawl is driven out by the gear in either direction of rotation. The degree to which the ideal can be attained is limited; each contacting surface of the pawl provides centralizing action in one direction of rotation and arresting action in the other.

Study of the magnitude of each of these factors is greatly facilitated by the pawl study method. It can easily be seen from *Fig.* 7 how it is possible to check a pawl surface quickly for its arresting and centralizing qualities.

Curves in *Fig.* 8 show the ratio of gear moment to pawl moment as a function of gear rotation. Although these curves do not represent actual energies involved, they permit estimation of the effectiveness of a given pawl since the net stopping energy is proportional to the area between the arresting and the centralizing moment-ratio curves.

In *Fig.* 7 the gear is 6 degrees from centralized position for both centralizing and arresting actions. Corresponding ratio values are plotted on the 6-degree ordinate in *Fig.* 8.

From an energy determination based on the pawl study data it was found that the pawl is theoretically capable of absorbing 0.216 in-oz before overthrow would occur. This is almost twice as much as the calculated rotational energy of the dial gear train, 0.111 in-oz.

Such a safety factor seemed ample to cover experimental errors and all known shortcomings in the mechanism. This assumption was confirmed by all single-order transfer tests. Simultaneous transfer tests, however, showed a peculiar discrepancy in this performance. When three or four orders at the right were transferring, an overthrow would occur in the leftmost order of this group.

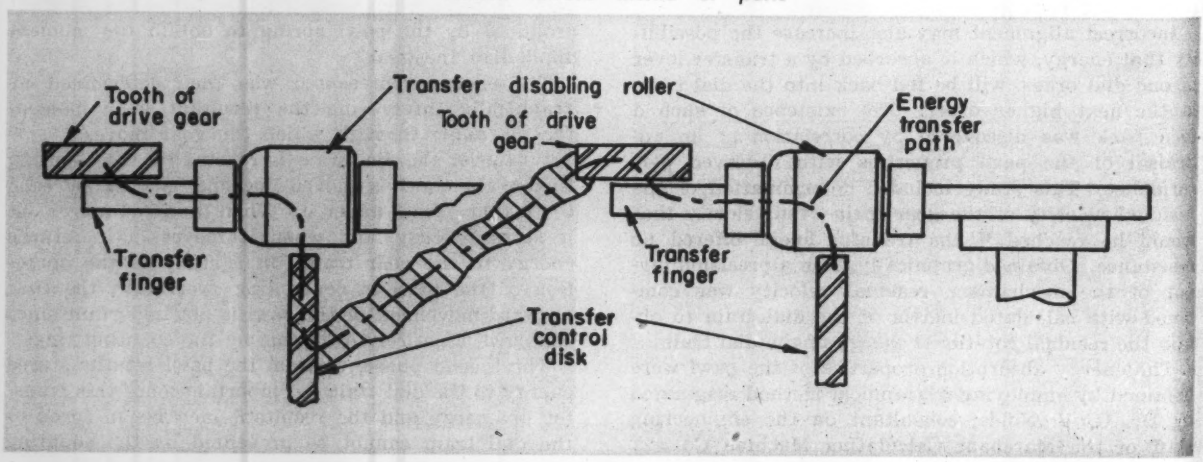
From further study it was found that transfer of energy from lower to higher orders (from right to left) was responsible for the overthrow. In this situation, all orders to the right of the failing order are in operation and their transfer disabling rollers are entering the notches in the transfer control disks. Under this condition, at the point in the drive path when the gear has just reached the home position, the dial train has its full energy of rotation. As the action continues, the dial train rotates until the edge of the transfer control disk notch contacts the roller. At this point the dial train is arrested and its energy is transmitted to the transfer finger via the roller. The energy path is diagrammed in *Fig.* 9.

Since the transfer fingers are still in driving position and since they are somewhat loose on their pivots, energy will be carried to the drive gear immediately to the left. The transmission of energy in this manner puts an additional requirement on the pawls. The pawl in a given order must work to absorb the normal rotational energy of its order, plus any additional energy due to this transmission. The accumulation of energy in any particular order depends upon the efficiency of this transmission system, and upon the number of orders to the right of the particular order.

Confirmation of this energy transfer theory was obtained by testing a machine in which contact between the control disk and the transfer disabling roller was prevented by an enlarged notch in the control disk.

These studies thus proved that further work should be directed toward reduction of dial train inertia rather than toward additional refinement of the actuator proper. In general, reduction of inertia involved

Fig. 9—Although overthrow was prevented in a single order, simultaneous arresting of gear trains in a series of orders set up cumulative reactions. Energy was transferred via the diagrammed path and accumulated to cause overthrow of third or fourth order to left. This problem turned attention toward inertia of parts



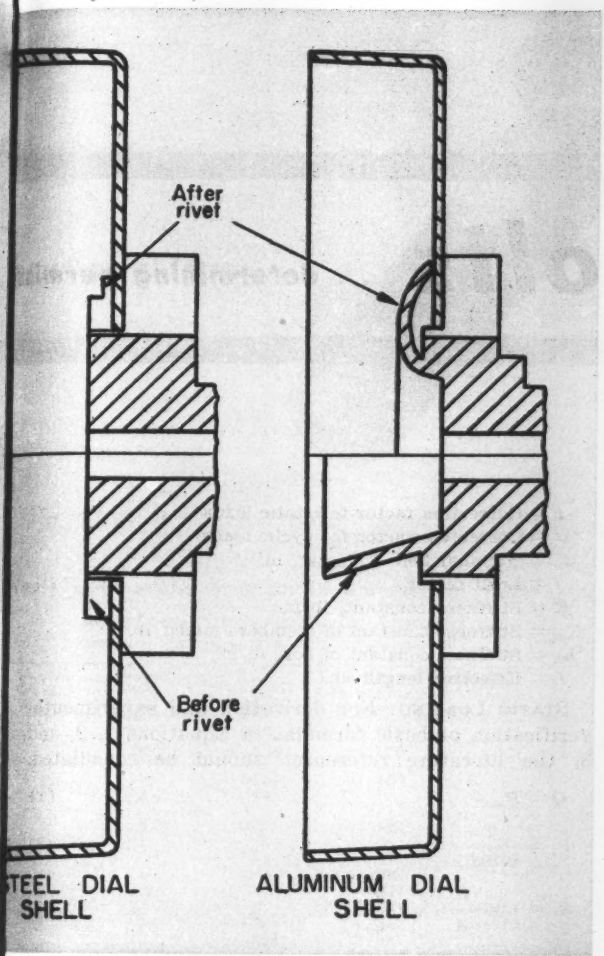


Fig. 10—Reducing inertia of the dial shell by use of aluminum instead of steel was the final refinement in obtaining freedom from overthrow. Problem of riveting aluminum to resist dynamic forces of operation was overcome with petal-type rivet shown

determination of the minimum amount of material for parts that would be durable and could be practically manufactured.

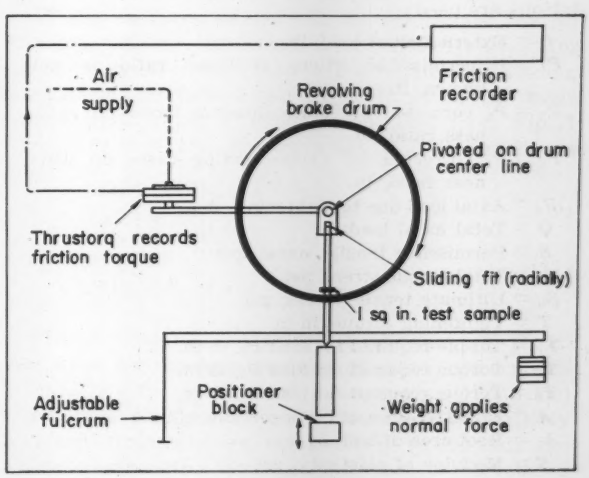
The most important single improvement and perhaps the most interesting detail in this phase was the rearrangement of the dial assembly to increase the strength of the joint between the steel gear and the newly adopted aluminum dial shell. The high peak load resulting from the accelerations and decelerations that occur in the actuation of the dial train had defied all previous efforts to make a durable assembly with the conventional form of riveting. Aluminum is not sufficiently strong to develop adequate strength in a splined peel die rivet of the type illustrated in *Fig.* 10. Upsetting pressures that normally develop an interlocking action when employed with steel parts simply push aluminum out of the way. With the new structure, *Fig.* 10, the petals that separate from the steel cone provide on the aluminum a controlled pressure that does no damage.

Inertia reduction was the final refinement of the mechanism. It provided such a safety margin against misoperation through overthrow that only reasonable accuracy of adjustment is required in the production of this mechanism. An experimental model was tested at 2300 cpm without overthrow. Production checks are conducted at 1800 cpm. At this test speed, dependability of manufactured units is assured for 1350-cpm operation and undue strain and possible damage of other parts are avoided.

Testing Automotive Brake Linings

ACCURATE brake lining tests, including evaluation of friction levels, determining the ability of a material to withstand heat and comparing the rate of wear of lining samples are accomplished on the machine illustrated schematically in the accompanying drawing. A standard automotive type brake drum is rotated by an adjustable-speed drive and the sample held against the drum with any desired pressure. Thermocouples, through slip rings, measure the temperatures developed on the brake friction surface. To permit higher temperatures, heating coils are used.

In the machine, developed by the Bendix Research Laboratories for the Marshall Eclipse Division of Bendix, the tendency of the lining to rotate with the drum is overcome by holding the sample being tested in an adapter. This adapter is itself part of the dead load on the sample, and is linked through a torque arm to the flexible diaphragm of a Hagen "Thrus-Torq" or load cell. This device responds automatically to load on the diaphragm by using compressed air pressure to keep the diaphragm in position. The air pressure required to hold the diaphragm is thus a measure of the torque developed by the lining.



Steel Bolts . . . determining permis

DURING the last few years, much work has been done on the correlation of bolt tightening with the loads and life of bolts. As many factors enter into these considerations, the information obtained was rarely consolidated into ready reference tables for the use of the designer. By restricting the data to steel bolts and studs, assembled without special lubrication, and loaded axially without bending or shear stresses imposed by the load, it is possible to devolop tables of considerable value to the machine designer because they will cover a large percentage of bolt uses with sufficient accuracy. These tables must be based on the following requirements for satisfactory performance of bolts and studs:

1. The total tensile stress due to tightening and external load should not exceed permissible stress
2. The axial load due to tightening should be at least equal to the external load to insure against opening of the joint and to insure minimum stress range for cyclic loads
3. For cyclic loads, the mean load and load range should be correlated to reduce the danger of fatigue failure.

The literature listed in the bibliography permitted the development of simplified formulas fulfilling these requirements from which in turn bolt load data TABLES 1 and 2 were obtained. The following notations are used:

P = External axial load, lb
P_1 = P permissible where stiffness ratio is not known, lb
P_2 = P_1 corrected for static loading based on stiffness ratio, lb
P_3 = P_1 corrected for cyclic loading based on stiffness ratio, lb
P_i = Axial load due to tightening, lb
Q = Total axial load, lb
S = Permissible tensile stress, psi
S_t = Total tensile stress, psi
S_u = Ultimate tensile stress, psi
T = Tightening torque, lb-in.
T_1 = Torque required for load P_1, lb-in.
T_2 = Torque required for load P_2, lb-in.
T_3 = Torque required for load P_3, lb-in.
A = Effective area of cross section, sq in.
A_r = Root area of bolt, sq in.
E = Modulus of elasticity, psi
c = Correction factor for static loads
c' = Correction factor for cyclic loads
d_n = Nominal bolt diameter, in.
f = Load factor
K = Stiffness constant, lb/in.
K_m = Stiffness constant of members joined, lb/in.
K_b = Stiffness constant of bolt, lb/in.
L = Effective length, in.

STATIC LOADING: For derivation and experimental verification of basic formulas in Equations 1, 2, and 3, the literature reference* should be consulated.

$$Q = P_i + fP \quad \ldots\ldots (1)$$

$$P_i = \frac{T}{0.19 d_n} \quad \ldots\ldots (2)$$

$$S_t = 1.35 \frac{P_i}{A_r} + f \frac{P}{A_r} \quad \ldots\ldots (3)$$

where $f = 1/(1 + K_m/K_b)$ and the constant 1.35 is a correction factor used to allow for shear stress due to tightening. The stiffness constants K can be determined for any structure from the formula

$$K = \frac{\text{load}}{\text{elongation}} = E \frac{A}{L} \quad \ldots\ldots (4)$$

In cases where the effective area and effective length of the bolted members are difficult to determine, the use of actual measurements is recommended. The approximate stiffness ratio can be obtained from measurements of deformation alone, as

$$\frac{K_m}{K_b} = \frac{\text{Elongation of bolt}}{\text{Compression of members}}$$

To fulfill Requirement 1, $S \geqq S_t$ To fulfill Requirement 2, $P_i \geqq P$. Then, from Equation 3, for limiting values of P and S_t

$$S = (1.35 + f) \frac{P}{A_r} \quad \ldots\ldots (5)$$

$$P = \frac{S}{1.35 + f} A_r \quad \ldots\ldots (6)$$

and from Equation 2,

$$T = 0.19 d_n P \quad \ldots\ldots (7)$$

In actual tightening, the torque should be increased

* References are listed at end of article.

ernal axial loads

By Alex Brunner
Mechanical Development Laboratory
E. I. du Pont de Nemours & Co.
Wilmington, Del.

Table 1—Working Strength of Commercial Steel* Bolts and Studs in Axial Loading
(NC and NF Series, 25,000 psi Yield Strength)

Nominal Bolt Size (Inches)	Threads Per Inch	Root Area (Sq in.)	Allowable External Load in Tension (lb)	Required† Tightening Torque, (lb-in.)
¼	20	0.0269	140	7
	28	0.0326	170	9
5/16	18	0.0454	240	16
	24	0.0524	280	18
⅜	16	0.0678	360	28
	24	0.0809	430	33
7/16	14	0.0933	490	45
	20	0.1090	580	53
½	13	0.1257	660	69
	20	0.1486	790	81
9/16	12	0.1620	860	100
	18	0.1888	1,000	115
⅝	11	0.2018	1,070	140
	18	0.2400	1,270	165
¾	10	0.3020	1,600	250
	16	0.3513	1,870	290
⅞	9	0.4193	2,200	400
	14	0.4805	2,550	460
1	8	0.5510	2,950	600
	14	0.6464	3,450	720
1⅛	7	0.6931	3,650	860
	12	0.8118	4,300	1,000
1¼	7	0.8898	4,700	1,230
	12	1.0238	5,400	1,400
1⅜	6	1.0541	5,600	1,600
	12	1.2602	6,700	1,900
1½	6	1.2938	6,800	2,150
	12	1.5212	8,100	2,500
1⅝	5	1.7441	9,200	3,350
2	4½	2.3001	12,200	5,100
2¼	4½	3.0212	16,000	7,400
2½	4	3.7161	19,700	10,200
2¾	4	4.6194	24,500	13,900
3	4	5.6209	30,000	18,600

* This table is to be used for general guidance. Where more accurate determination of allowable loads is required refer to formulas.
† Required torque can be obtained in two ways, by the use of torque wrenches or by varying the pull or wrench length until their product equals the value shown. The average pull of a man tightening a bolt with a large wrench has been found to be about 50 lb.

by approximately 10 per cent to compensate for friction between the nut and its bearing surface.

Equations 1 and 2 can be used direct to determine the maximum allowable external axial load of bolts and the required tightening torque. For extreme conditions, where the stiffness ratio, K_m/K_b' approaches 0, which would occur with members deforming much more than the bolt, the value for f approaches 1. It is, therefore, safe to assume this value where stiffness constants cannot be conveniently determined, which then makes Equations 8 and 9.

$$P_1 = \frac{S}{2.35} A_r \quad \ldots\ldots (8)$$

$$T_1 = 0.21 d_n P_1 \quad \ldots\ldots (9)$$

In Equation 9, allowance for friction is included.

Based on these formulas, TABLES 1 and 2 were prepared. For permissible tensile stress, S, one half the yield strength was selected. For TABLE 1, commercial steel bolts made of steel with 25,000 psi yield strength were assumed. For TABLE 2, alloy steel with a minimum yield strength of 50,000 psi was selected. For steels with a different yield strength or for other permissible stresses, table values should be multiplied by the ratio of the permissible stress for the selected material to the value for S.

Where stiffness values can be determined, or estimated, higher loads are permissible. Values for these loads and the corresponding required tightening torque can be determined by multiplying the table values by a factor c, which is obtained from *Fig.* 1 for the ratio K_m/K_b. The formulas for c, P_2 and T_2 are

$$c = \frac{2.35}{1.35 + f} \quad \ldots\ldots (10)$$

$$P_2 = cP_1 \quad \ldots\ldots (11)$$

$$T_2 = cT_1 \quad \ldots\ldots (12)$$

CYCLIC LOADING: To fulfill Requirement 3, Goodman's law for the determination of safe cyclic stresses is used. As for steels used in commercial bolts and commercial finishes the endurance limit (completely reversed stresses) can be assumed to be half the ultimate strength. Equation 13 can be developed

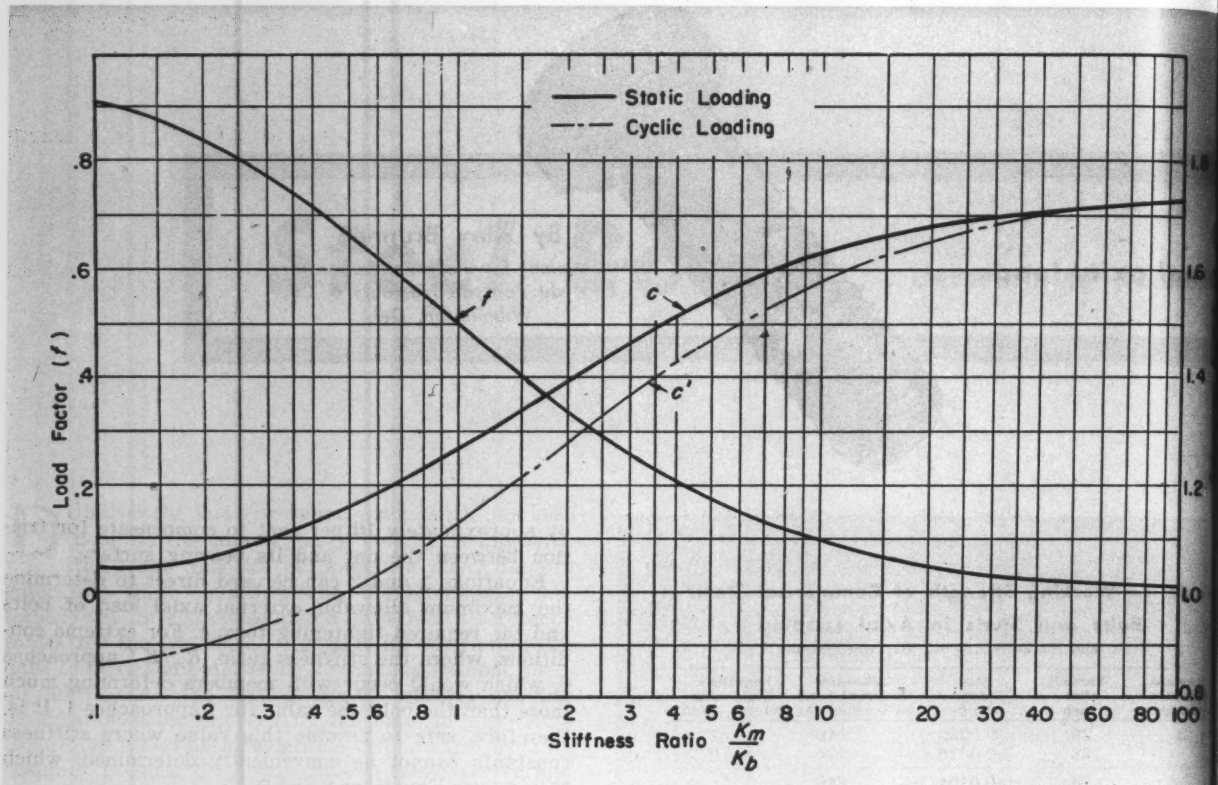


Fig. 1—Correction factors for load and torque. Load factor and correction factors for both static and cyclic loads are plotted against stiffness ratio

from this law for the ultimate tensile strength.

For $P=P_i$ (limiting value) from Equation 3 $S_{min}=1.35\ P/A_r$ and $S_{max}=1.35\ P/A_r+fP/A_r$ therefore the stress range $= fP/A_r$ From Goodmans' Law:

$$\frac{fP}{2A_r}=\frac{S_u}{2}\left[1-\frac{1}{A_r}\left(\frac{1.35P+fP/2}{S_u}\right)\right]$$

$$S_u=\frac{1}{A_r}\ (1.35P+1.5fP) \quad \ldots\ldots (13)$$

for $S_u=S$,

$$P=S\ \frac{A_r}{1.35+1.5f}$$

From Equation 8, $S=2.35P_1/A_r$. Then

$$P_3=\frac{2.35}{1.35+1.5f}\ P_1 \quad \ldots\ldots (14)$$

for $c'=2.35/(1.35+1.5f)$

$$P_3=c'P_1 \quad \ldots\ldots (15)$$

$$T_3=c'T_1 \quad \ldots\ldots (16)$$

Equation 15 will result in permissible loads P_3 greater than P_1 for all values of f greater than 0.67, which will cover most machine design applications. Therefore, load and torque values given in TABLES 1 and 2 can be used where stiffness values are not determined. If stiffness values are determined, factor c' can be obtained from *Fig.* 1 for the ratio K_m/K_b.

The example shown in *Fig.* 2 illustrates the use of the formulas and tables. Two aluminum parts are

Table 2—Working Strength of Alloy Steel* Bolts and Studs in Axial Loading

(50,000 psi Yield Strength)

Nominal Bolt Size (inches	Threads Per Inch	Root Area (Sq in.)	Allowable External Load in Tension (lb)	Required† Tightening Torque, (lb-ft)
1	8	.551	5,900	100
1⅛	8	.778	8,250	160
1¼	8	.929	9,800	210
1⅜	8	1.155	12,200	320
1½	8	1.405	15,000	390
1⅝	8	1.680	17,800	500
1¾	8	1.980	21,000	640
1⅞	8	2.304	24,500	800
2	8	2.652	28,200	980
2⅛	8	3.020	32,000	1,200
2¼	8	3.423	36,300	1,420
2⅜	8	4.292	45,500	2,000
2¾	8	5.259	56,000	2,700
3	8	6.324	67,000	3,500

* This table is to be used for general guidance. Where more accurate determination of allowable load is required, refer to formula

†Required torque can be obtained in two ways, by the use of torque wrenches or by varying the pull or wrench length until their product equals the value shown. The average pull of a man tightening a bolt with a large wrench has been found to be about 50 lb.

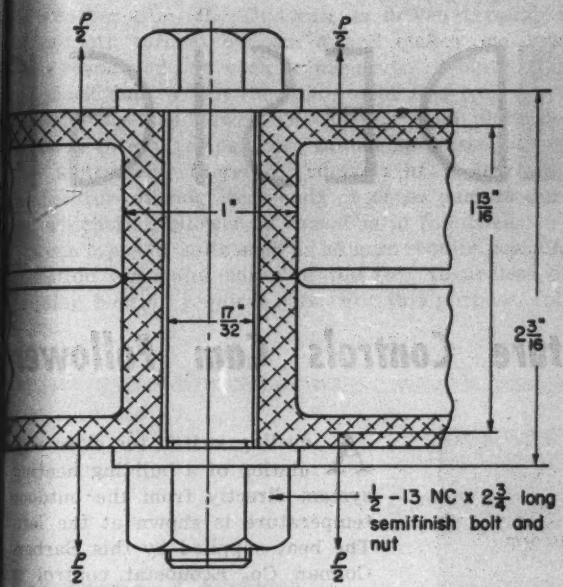


Fig. 2—Above—Two aluminum parts bolted together with bolt loaded in tension

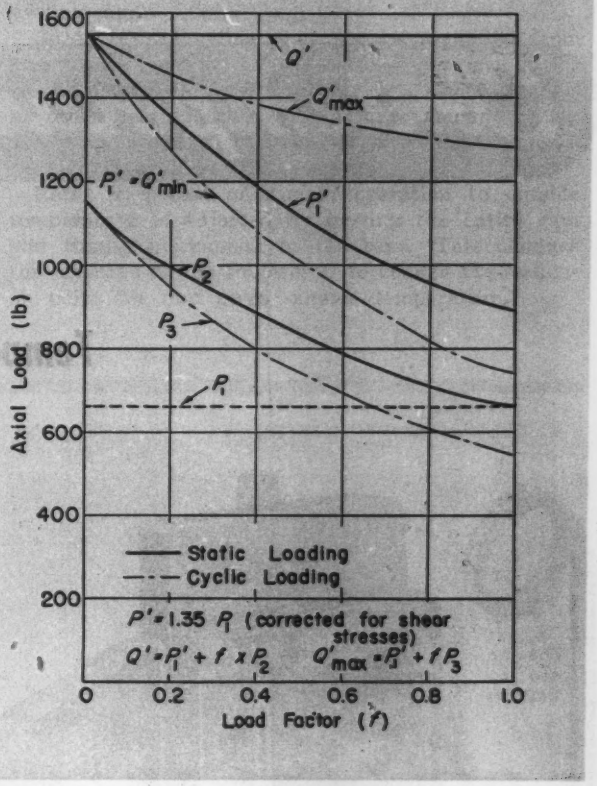


Fig. 3—Right—Comparison of axial loads for a ½—13 bolt

bolted together with the bolt loaded in tension. Effect of ribs, washers and exposed threads are neglected. Wanted: To find the allowable external load in tension and the required tightening torque.

From TABLE 1, $P_1 = 660$ lb and $T_1 = 69$ lb-in. Stiffness ratio, using Equation 4 becomes

$$K_m = \frac{E\,A_m}{L_m} = \frac{10 \times 10^6 (0.785 - 0.222)}{1.8125} = 3.11 \times 10^6$$

$$K_b = \frac{E\,A_b}{L_b} = \frac{30 \times 10^6 \times 0.196}{2.1875} = 2.69 \times 10^6$$

$$\frac{K_m}{K_b} = \frac{3.11 \times 10^6}{2.69 \times 10^6} = 1.15$$

Then, from *Fig.* 1 for $K_m/K_b = 1.15$, the load factor $f = 0.46$ and the correction factors are $c = 1.29$ and $c' = 1.15$. For static loading:

$$P_2 = cP_1 = 850 \text{ lb, and}$$
$$T_2 = cT_1 = 90 \text{ lb-in.}$$

For cyclic loading:

$$P_3 = c'P_1 = 760 \text{ lb, and}$$
$$T_3 = c'T_1 = 80 \text{ lb-in.}$$

In *Fig.* 3 are illustrated the variations in P_2 and P_3 as factor f changes. Factor f can be determined from *Fig.* 1 for the different stiffness ratios. It was selected as the basis for this graph in order to shorten the curves. The ratio of values or shape of curves remains the same for all sizes of bolts, but actual loads are given for greater clarity and correlation with the example given in *Fig.* 2.

Where bolts are used for limited applications, e.g., when gaskets are never used and only steel members are to be considered, TABLES 1 and 2 can be revised for higher basic values by using the lowest P_2 and T_2 encountered in this work. The tables should not be used for applications where considerable bending and shear loading is encountered, where severe corrosive or other conditions affecting bolt performance are prevalent, or where internal pressures require code design. The required tightening torque can be obtained by the use of torque wrenches or by varying the pull or wrench length until their product equals the value wanted. The average pull of a man tightening a bolt with a large wrench was found to be approximately 50 lb.

The basic relationship between torque and initial axial load due to tightening, Equation 2, is based on steel bolts and nuts. Where other materials are used or lubricants specified, a new constant is needed in this formula which must be determined experimentally.

In conclusion, the writer wishes to acknowledge the assistance he received from the engineering department standards committees of the Du Pont Co.

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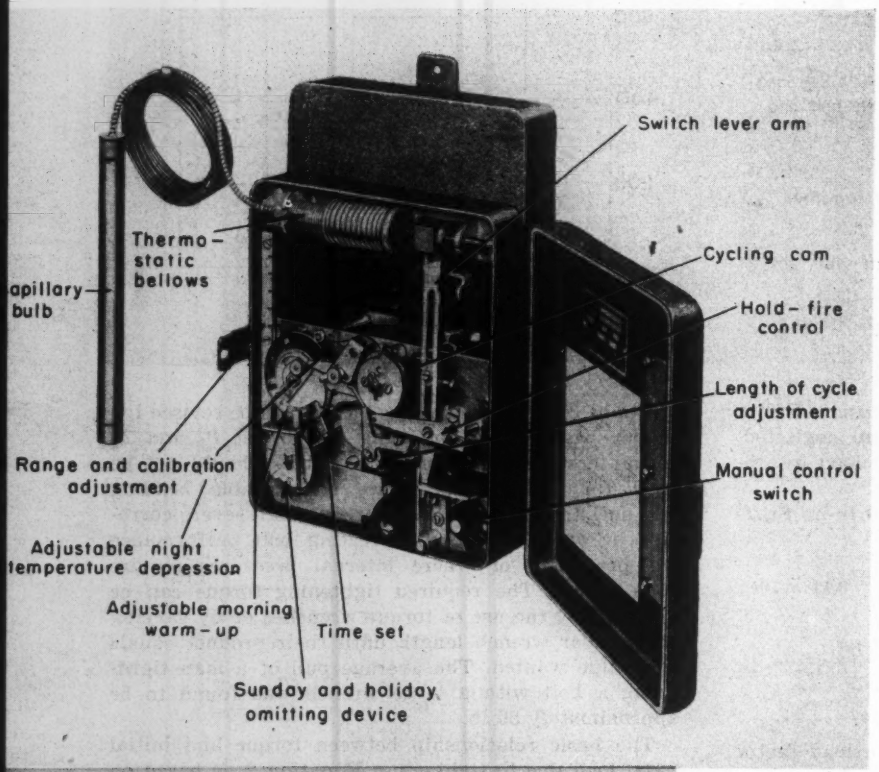
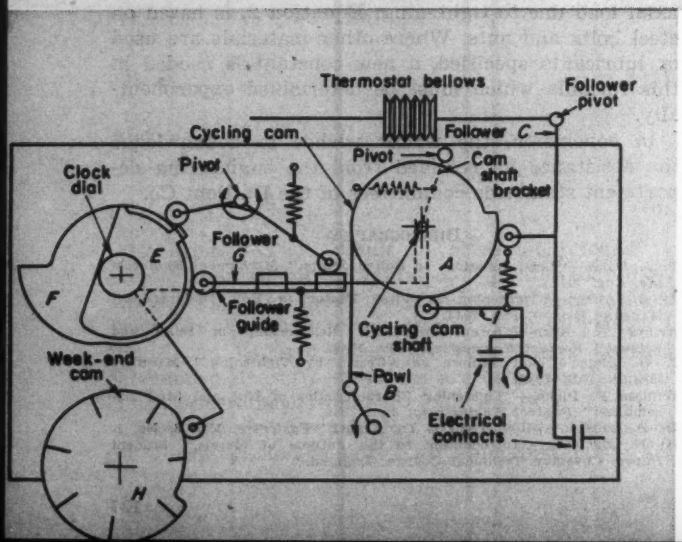
Contemporary DESIGN

Temperature Controls Cam Follower





A cycling switch for close regulation of a building heating system directly from the outdoor temperature is shown at the left. The heat supplied by this Barber-Colman Co. Econostat control is proportional, in general, to the heat loss of the building and is therefore not dependent on the temperature change of any particular room.

The timing mechanism is shown schematically, left, below, and operates as follows: The cycling cam, *A* rotates at constant velocity through a motor-driven eccentric pawl, *B*. As the cam rotates, the follower *C* pivots at its upper end to close the electrical contacts at its lower end and thus intermittently operate the heating system. The follower pivot is on the free end of a thermostat bellows controlled by a bulb in the outside air. As the outside temperature changes, the bellows expands or contracts, changing the pivot location and altering the switch-closed period per revolution of the cycling cam. Thus, the heating plant operation will be dependent upon outside temperature.

A 24-hour clock permits heating plant operation at reduced temperature during the night and at week-ends. The lug on cam *E* mounted on this dial trips a lever which permits the cycling camshaft to move away from the follower *C*. This repositioning of the cycling cam reduces the switch-on period and duration of operation of the heating plant. Change from night depression to day temperature is accomplished by the cam *F* on the clock dial. Follower *G* is actuated by this cam and returns the cycling cam to its original position.

Adjustable stops which limit the movement of the cycling camshaft regulate the amount of night or week-end temperature depression. Time settings for the duration of depressed night temperatures are

made by moving the cams on the graduated clock dial.

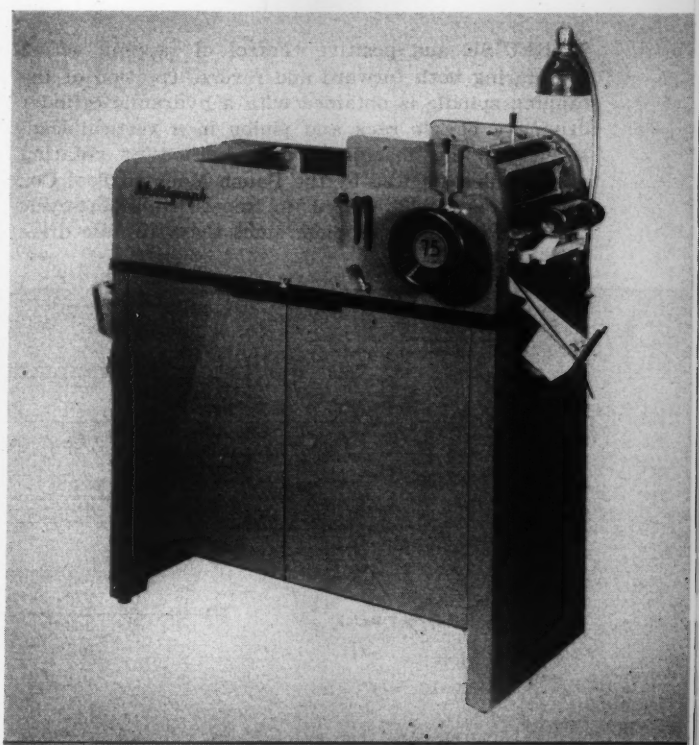
Week-end temperature reduction is accomplished by another cam, *H*. This cam is driven through a seven-tooth ratchet by cam *F* and makes one complete revolution per week or per seven revolutions of the clock dial. When the follower of this cam drops into the week-end dwell, the change from night depression to day temperature cannot be accomplished. The instrument, therefore, controls at a depressed temperature during week-ends or other periods during which the follower of cam *F* is in the dwell.

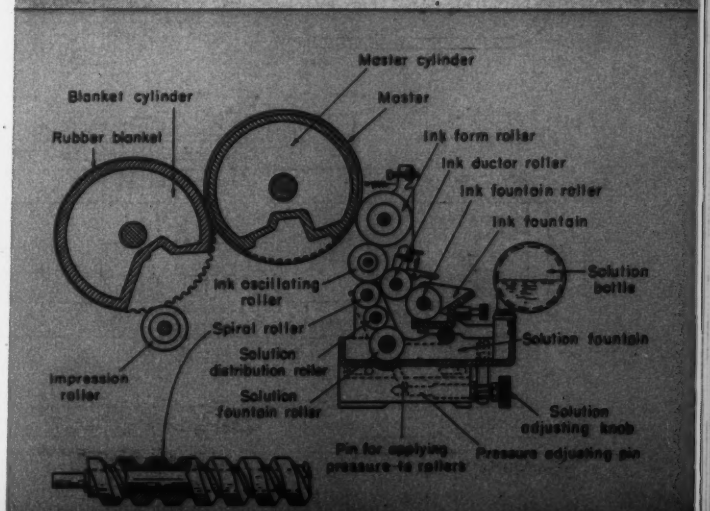
Some types of units such as stokers require periodic operation for maintenance of the fire, regardless of building heating requirements. For this purpose, follower *I* closes contacts to operate the heating system for a short period during each revolution of the cycling cam.

Speed of the cyling cam can be regulated from one to four teeth of the drive ratchet per pawl stroke by adjusting the pawl eccentricity. When panels or other heating units with a large amount of lag are used, speed of the cam is increased for more frequent operation of the firing unit.

Ratio of period of system operation to outside temperature is adjusted by moving the entire cam and timing mechanism in the case. This changes the leverage of the follower *C* to change the switch-on point for any given outside temperature.

Accurate Control of Ink Flow



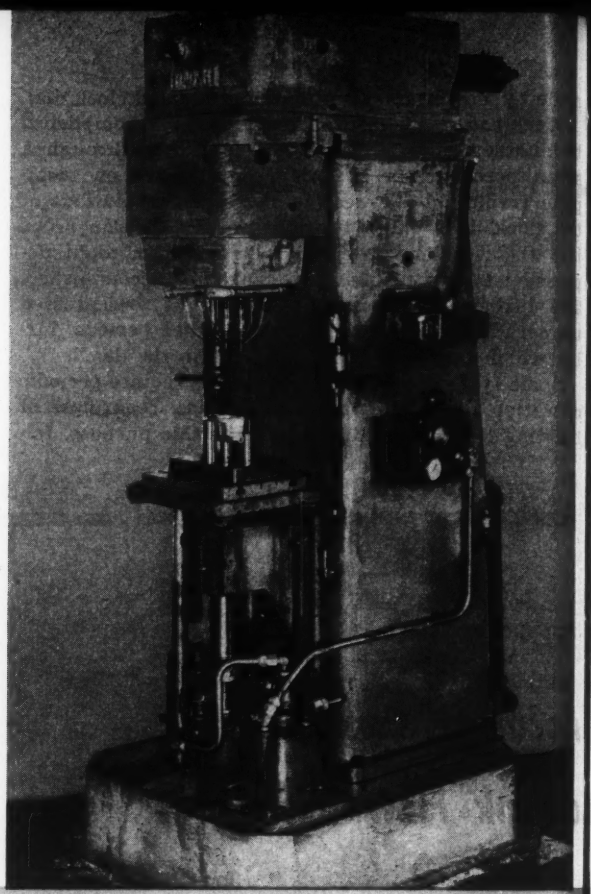


SIMPLIFIED ink control on the Multigraph duplicator, right, insures more uniform copies by combining the flow of both ink and moisture simultaneously through a single set of rolls. In this Addressograph-Multigraph Corp. Simflo control system, a film of duplicating ink from the ink fountain, drawing, below, is picked up by the ink fountain roller and carried by the ductor roller to an ink oscillating roller. Thickness of the ink film is controlled by a series of adjusting screws across the back of the ink fountain. Simflo solution in the solution fountain is picked up by a fountain roller and carried to the ink oscillating roller through distribution and spiral rollers. The amount of moisture carried to the ink oscillating roller is controlled by two adjusting knobs at the back of the solution fountain. Once adjusted, balance between ink and moisture is automatically maintained throughout the run.

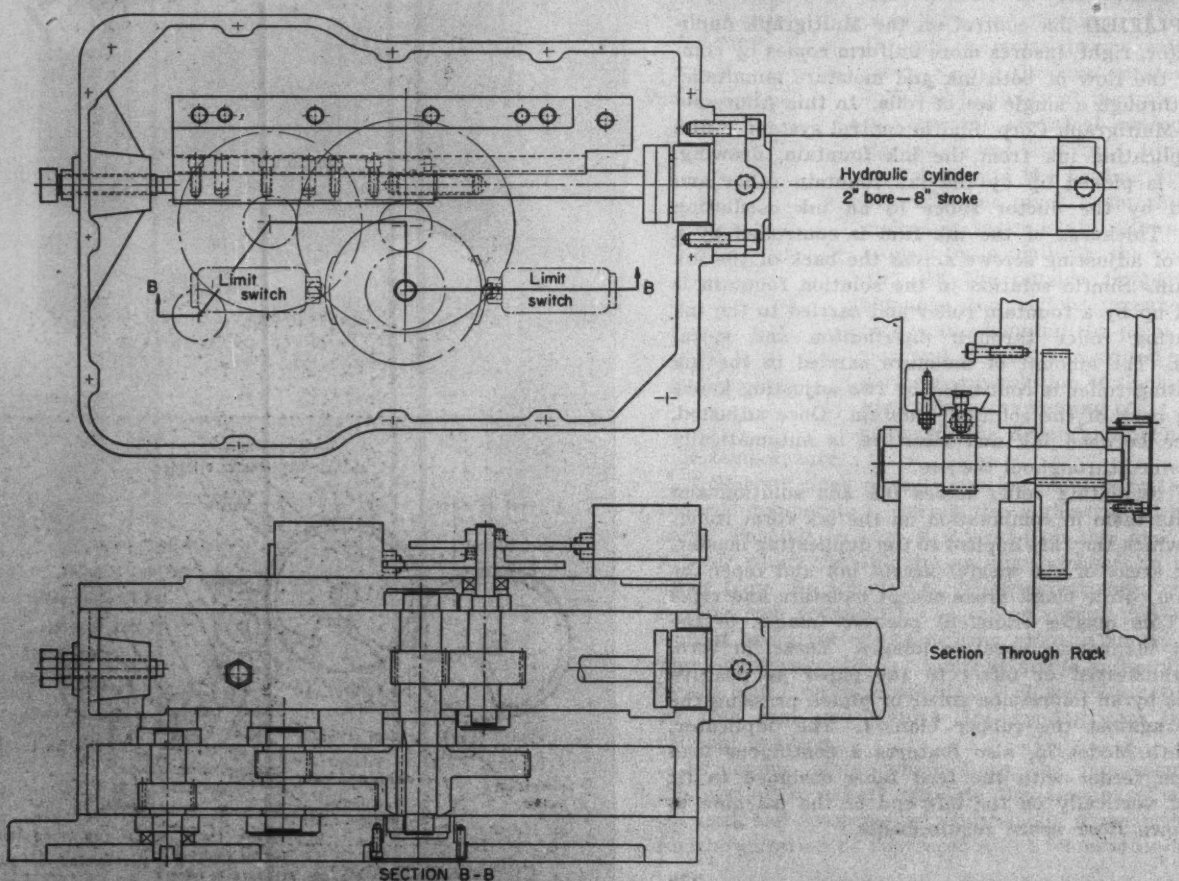
The oscillating roller mixes ink and solution and deposits them in combination on the ink form roller, from which they are applied to the duplicating master. Image areas of the master accept ink and repel the solution, while blank areas accept moisture and repel ink. This master transfers positive images to the rubber blanket as negative images. These, in turn, are transferred or offset to the paper as positive images by an impression roller or platen pressing the paper against the rubber blanket. The duplicator, Multilith Model 75, also features a continuous load vacuum feeder with the feed table designed to fit almost vertically on the left end of the machine to cut down floor space requirements.

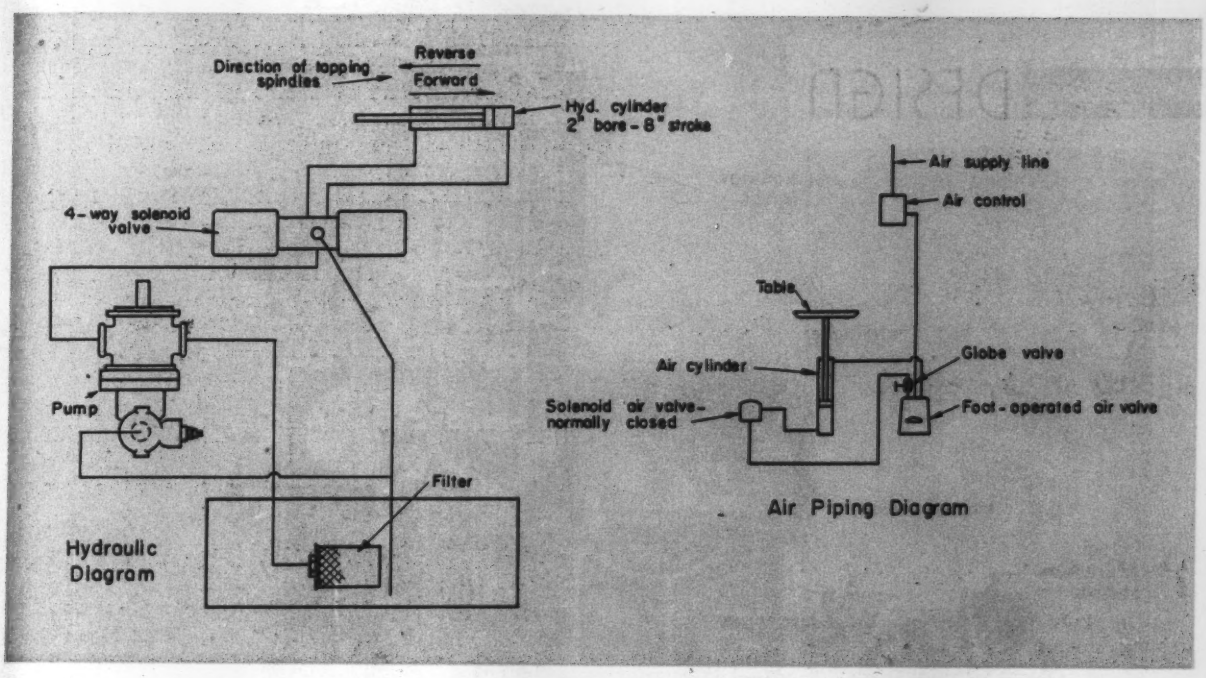
Contemporary DESIGN

Hydraulic Piston Actuates Spindles



PRECISE and positive control of tapping action during both forward and reverse rotation of the tapping spindle is obtained with a hydraulic cylinder driving a simple rack and pinion in a vertical lead-screw tapping machine. This method of rotating the spindles, devised by the Baush Machine Tool Co., is especially well suited to repetitive, short-cycle operations such as tapping, since the hydraulic drive



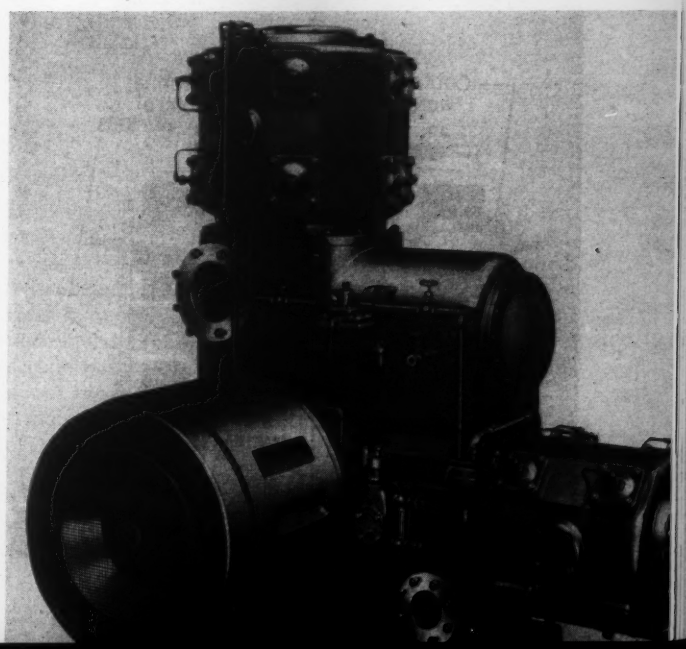


cylinder can be made to complete both forward and reverse strokes in an extremely short time. Since this machine is not subject to the limitations of ordinary tapping machines using motor drives, production is usually limited only by the time required for loading and unloading parts.

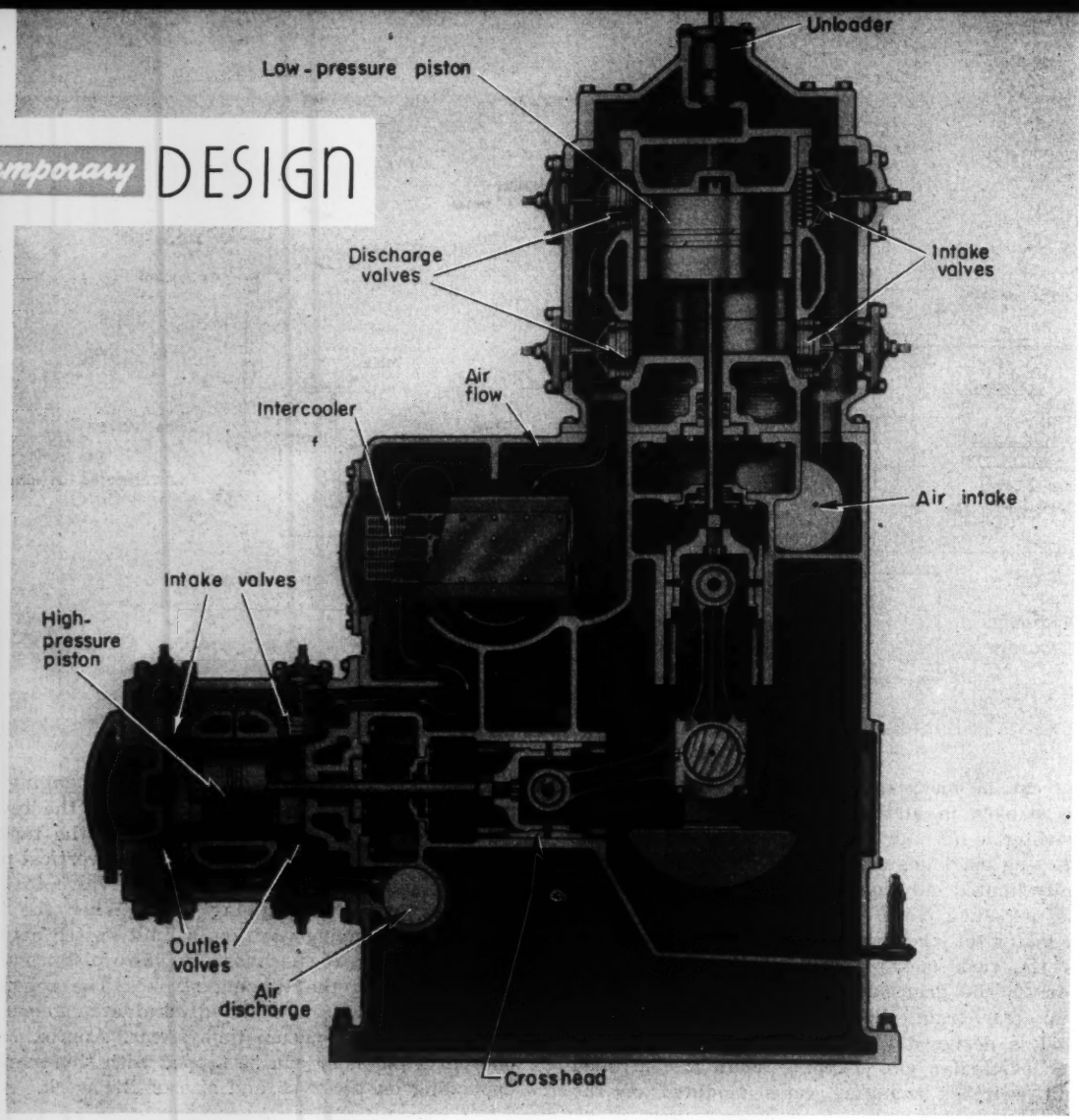
The piston of the horizontal hydraulic cylinder carries the rack meshing with a pinion which, in turn, drives the gearhead section through a double speed-up gear train, drawing opposite page. This gearhead is designed for the tap spacings required for each particular job. Tapping depth is controlled by limit switches engaging cams mounted on the shaft which also carries the pinion engaging the rack. These limit switches direct oil to the reverse side of the drive cylinder to withdraw the taps.

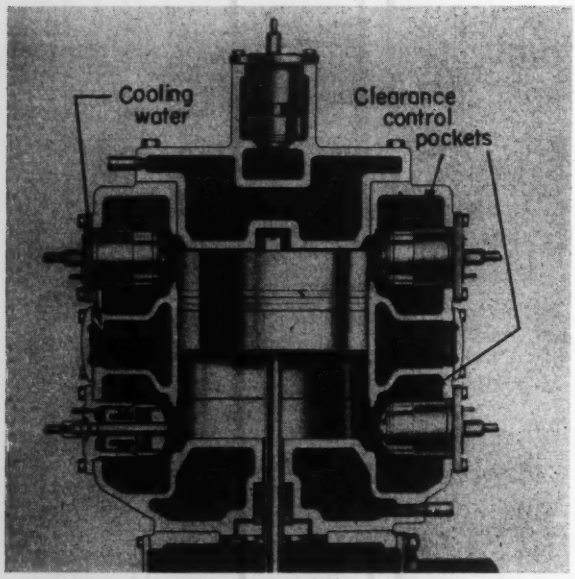
A work table carried on the ram of a vertical pneumatic cylinder is operated by a foot valve to bring the work up to the tapping head. When the table has reached tapping position, a limit switch actuates a solenoid to start the hydraulic drive piston moving to the left for the tapping stroke. The schematic diagrams, above, show the general arrangement of the hydraulic and pneumatic systems. Approximately 600 parts per hour can be tapped with this machine, depending on the type and size of the work.

Frame Provides Air Ducts



UNUSUAL design of a line of air compressors, right, makes use of the compressor frame for air passages, as shown in the cutaway view, top of next page. These Ingersoll-Rand compressors are heavy-duty, double-acting, water-cooled, crosshead type units with two cylinders—one vertical low-pressure cylinder and one horizontal high-pressure cy-





linder. Primary inertia forces on the crankshaft are balanced by making the larger, low-pressure piston from an aluminum alloy so that its weight equals that of the cast-iron high-pressure piston. Full-floating, pressure-lubricated main and crankpin bearing sleeves are also aluminum alloy and rotate freely to give a lower rubbing speed and consequent longer life. A counterflow, tube-and-finned intercooler fits within the compressor frame. Compressor valves are a new design of the well known channel valve type found on previous Ingersoll-Rand compressors.

The larger sizes employ five-step clearance control, whereby cylinder clearance can be varied by opening from one to four additional clearance pockets, shown in the cutaway drawing, left. Cylinder capacity and therefore compressor output can thus be varied in steps to suit the demand.

The XLE compressors are normally powered by synchronous motors rated 125 to 350 hp, with rotors attached directly to the compressor crankshafts. Units are rated at 80 to 125 psi and come with 7, 8½ and 10-inch strokes.

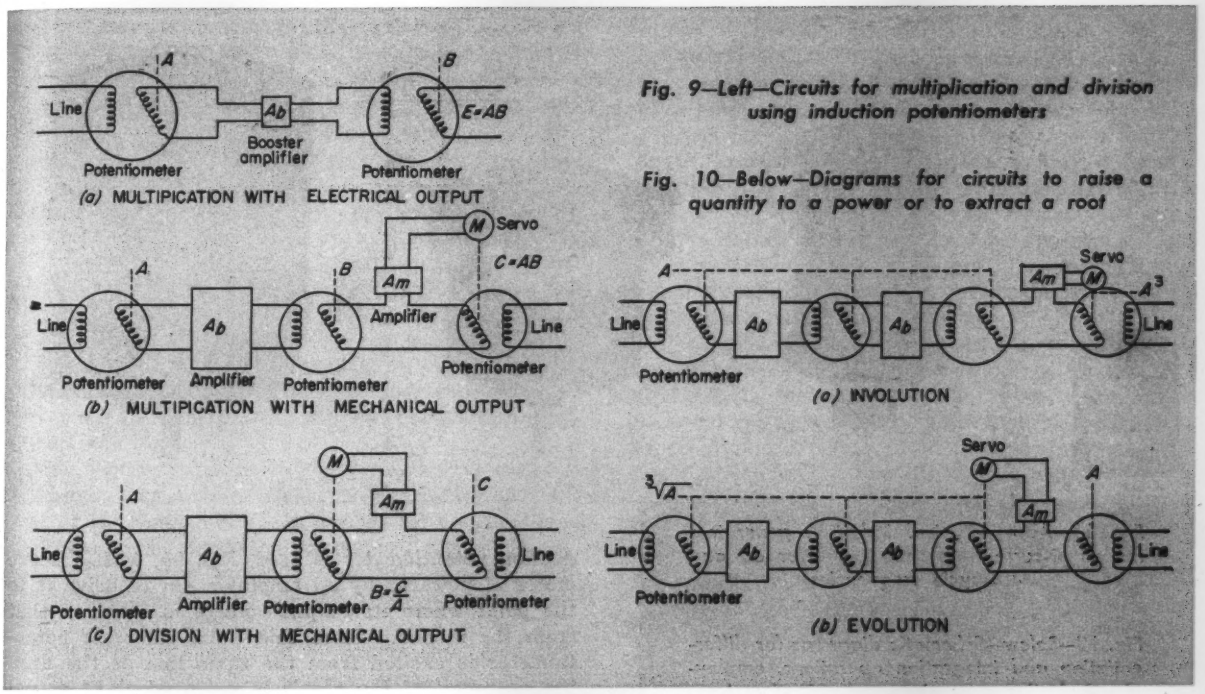


Fig. 9—Left—Circuits for multiplication and division using induction potentiometers

Fig. 10—Below—Diagrams for circuits to raise a quantity to a power or to extract a root

Employing Computer Components in Machine Control

Part 2–Complex Operations

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IN THE preceding article of this series various methods of performing the operations of addition and subtraction were discussed. The present article is devoted to the operations of multiplication and division, as well as the more complex problems of algebra, calculus and trigonometry.

Although addition and subtraction are performed by the same means, the difference being only in the sense of rotation or the way in which voltages are connected in series, the same is not quite true of the other inverse operations of multiplication and division.

MULTIPLICATION AND DIVISION: Multiplication is usually accomplished by means of induction potentiometers. One potentiometer is excited from a line at constant voltage and turned through an angle proportional to one of the quantities to be multiplied. The output of this potentiometer is used to excite a second unit which is turned through an angle proportional to the second quantity. The output of the second potentiometer is then proportional to the product of the two quantities concerned.

Because of the finite output and input impedances of the induction potentiometer, it is not permissible to impose the load of one unit on another. Instead, a booster amplifier is interposed between the two units. This is essentially an amplifier having a voltage gain very close to unity but having a high input

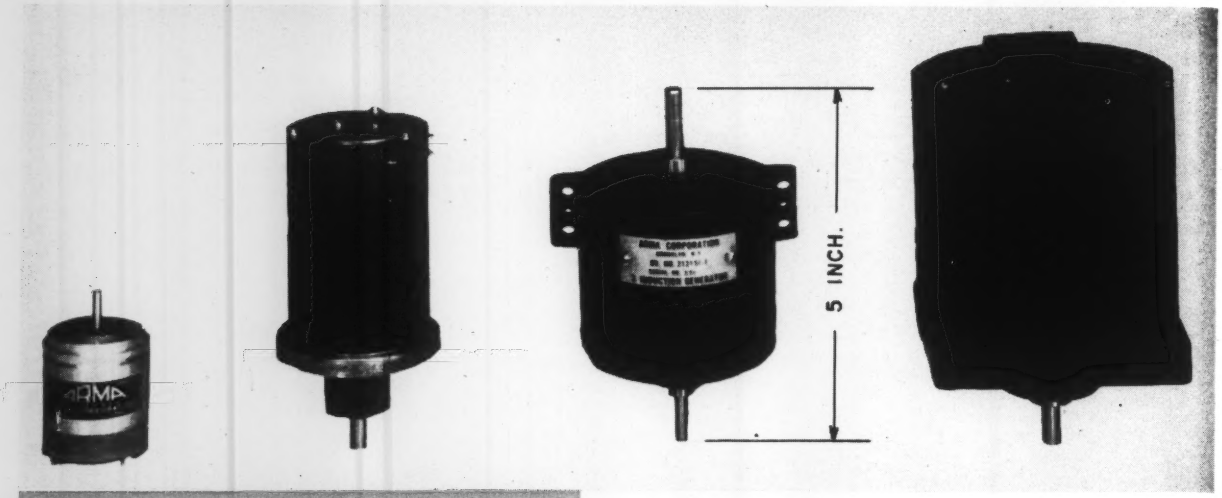
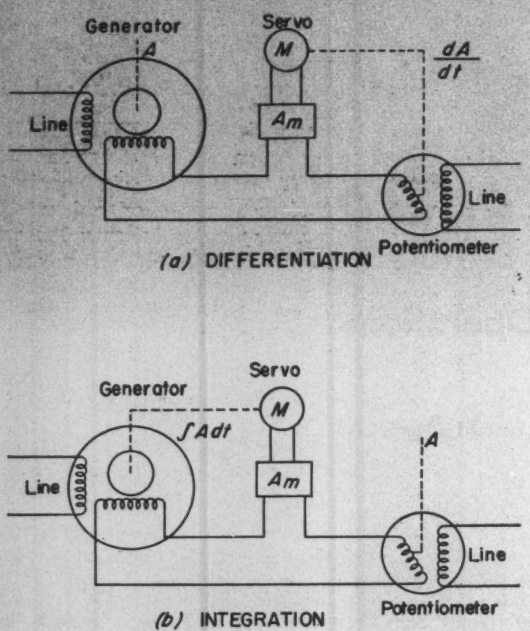


Fig. 11—Above—Typical induction generators for direct-current operation and for 60 and 400-cycle frequencies

Fig. 12—Below—Schematic diagrams for differentiation and integration operations, employing induction generators and potentiometers



impedance and a low output impedance. With this are combined circuits which compensate for the primary resistance and leakage reactance of the second potentiometer. A block diagram of this multiplication circuit is shown in *Fig. 9a* where A and B are the input quantities.

This procedure gives a voltage proportional to the product of two rotations. If it is desired to obtain a rotation proportional to this product, a third induction potentiometer is used, *Fig. 9b*, with a servo motor M powered by an amplifier Am to drive it to the point where its output voltage is equal to that from the second. Since this third induction potentiometer is excited from the same line as the first, the accuracy of the result is independent of actual line voltage over a wide range.

Division can be accomplished by a similar arrangement. In fact, the only essential difference is that the motor drives a different potentiometer. In *Fig. 9b*, showing multiplication, the A and B potentiometers are positioned as input quantities, and the servo motor drives the C potentiometer. Since A, B and C are the respective quantities represented by the potentiometers, then $C = AB$. In *Fig. 9c*, the A and C potentiometers are positioned as input quantities and the servo motor drives the B potentiometer so that as before, $C = AB$. This is, of course, $B = C/A$. The motor could, if B and C are positioned by external means, drive A, to make $A = B/C$.

INVOLUTION AND EVOLUTION: The operation of involution, or raising a quantity to a power, can be accomplished by means of cascaded potentiometers. The square is obtained by multiplying a quantity by itself, the cube by multiplying the square by the original quantity, and so on. Roots can be obtained by changing the potentiometers driven by the servo motor. Thus *Fig. 10a* shows a method for obtaining A^3, and *Fig. 10b* the analogous method for obtaining $\sqrt[3]{A}$. This procedure can be extended to fractional powers by first raising to a power and then extracting a root, or vice versa, or by splitting up the exponent to have the product of two or more integral powers or roots. Thus $A^{5/2}$ can be considered as the square root of A^5, or the fifth power of $\sqrt{A}$, or the product of A^2 and $\sqrt{A}$.

There are certain special cases that can be handled in particular ways. For example, a resolver, which has two electrical outputs proportional, respectively, to the sine and cosine of the angle through which it is turned, can be used for approximate squaring because $\sin^2 A = \frac{1}{2}(1 - \cos 2A)$, or for cubing since $\sin^3 A = \frac{1}{4}(\sin 3A - 3 \sin A)$, and for small angles $\sin A$ is nearly the same as A.

DIFFERENTIATION AND INTEGRATION: The operation of differentiation is performed with precision induction generators, such as shown in *Fig.* 11. Since it is most convenient to have all computations done with alternating current, these units are designed to produce an alternating voltage proportional to the speed of rotation. They are of the cup type, a metal cup being rotated between the core and yoke of the unit. Two windings are provided, an exciting winding and an output winding placed 90 electrical degrees apart. Attention is particularly directed to the large ratio of useful output voltage to the residual voltage at standstill. This ratio is of course exceeded by d-c generators, in which the residual is determined by thermal electromotive forces, but d-c generators have far more friction, inertia and electrical noise than a-c units.

The generator itself is a differentiator giving an electrical output proportional to the speed of rotation of its shaft. Where a mechanical rotation proportional to the derivative is required, a servo is employed to balance the output of the induction generator against that of an induction potentiometer. This is shown in *Fig.* 12*a*.

Integration is performed by means of a generator and a servo. Sometimes combination units are used in order to insure good coupling. *Fig.* 12*b* shows how the device functions. The generator, which is driven by the motor, has an output voltage proportional to its speed. The difference between the voltage which is to be integrated with respect to time, and the output voltage of the generator, is applied to the amplifier driving the motor. Thus the unit will run at a speed such that this difference is just enough to drive the motor. By using a high-gain amplifier satisfactory integration is obtained.

TRIGONOMETRY: Trigonometric problems are solved by means of electrical resolvers, *Fig.* 13. The outputs of a four winding resolver are, respectively, $A \sin x + B \cos x$ and $A \cos x - B \sin x$, where x is the angle through which the resolver is turned from its zero position, and A and B are the respective excitations of the two inputs. If one resolver is used to excite another, a booster amplifier is interposed, just as with induction potentiometers. By gearing a number of resolvers at different ratios, the assembly can be used as a harmonic synthesizer.

The simplest application of a resolver is to find the two components of a plane vector. A voltage proportional to the magnitude of the vector is applied to one input circuit, the other input winding being short circuited. The rotor is turned through the angle of the vector, and the output voltages are the desired components. *Fig.* 14 represents this situation. If shaft rotations are desired, the output voltages are matched by suitable servos against the outputs of induction potentiometers.

Another application is the inverse operation of finding a vector, given its components. To accom-

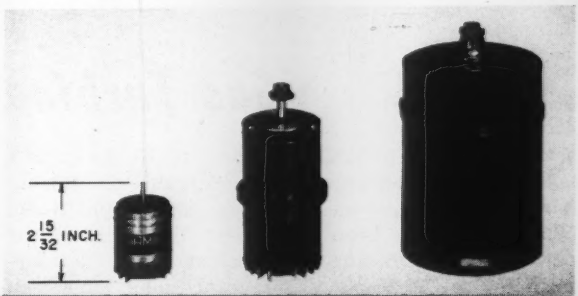
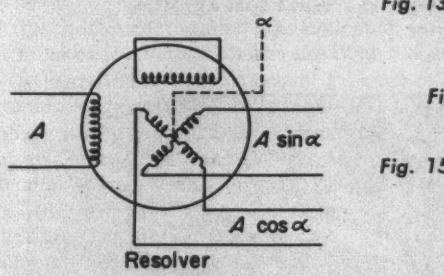


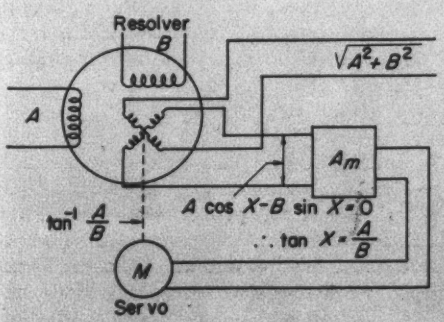
Fig. 13—Above—Electrical resolvers for solving trigonometric relations are available for both 60 and 400-cycle operation

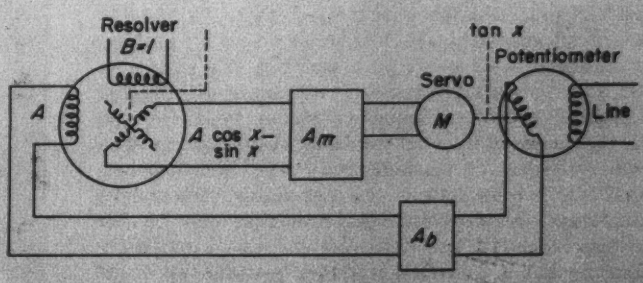
Fig. 14—Left—Components of a vector are obtainable from a resolver

Fig. 15—Left—Below—Method of obtaining resultant of perpendicular vectors

Fig. 16—Below—Use of a resolver to obtain the tangent







plish this, the components are applied to the two input windings and a servo is employed to rotate the resolver to the angle at which one of the coils has zero output as in *Fig.* 15. Then, from the fundamental equation of the resolver, $A \cos x - B \sin x = 0$, or $\tan x = A/B$, and the output of the other coil is $A \sin x + B \cos x$, which is $\sqrt{A^2 + B^2}$.

Where the resultant value $\sqrt{A^2 + B^2}$ can vary over a large range, the sensitivity of the servo system must be varied in accordance with this to obtain satisfactory performance. To accomplish this a vacuum tube attenuator is employed. This unit controls the gain of the amplifier driving the angle servo in accordance with the total excitation voltage of the resolver. In principle it is much like the automatic volume control used in radio receivers.

The resolver can be used to obtain the tangent, cotangent, secant and cosecant functions as well as the simple sine and cosine functions, *Fig.* 16 shows the connections for the tangent. Since $\tan x = \sin x/\cos x$, it follows that $\tan x \cos x - \sin x = 0$. As the output of one coil of a resolver is $A \cos x - B \sin x$, it is clear that if B is made unity, and A is varied so as to make this output zero, A must be $\tan x$. By using an induction potentiometer as the source of voltage, the tangent is available both electrically and mechanically. If it is needed electrically only, the potentiometer need not be linear. A somewhat similar arrangement can be used to obtain the secant.

Mechanical resolvers can of course be constructed to perform all the functions of electrical units. However, it is difficult to make them sufficiently rigid to assure accuracy over a range of radii approaching that of the electrical unit. The electrical units are good to about 0.1 per cent of excitation voltage over a range of 40 to 1. A mechanical resolver having a maximum radius of 10 inches, and requiring a circle more than 20 inches in diameter, would have to be made to a tolerance better than 0.00025-inch to duplicate this performance in resolving a vector.

The composition of two vectors to obtain the resultant is much more difficult. If the 10-inch radius slide in a mechanical resolver is to be positioned by the two components working at ¼-inch, it can be seen that the forces will be enormous. Now if the components suddenly reverse so that the new solution is approximately 180 degrees away, it is probably impossible to avoid spring great enough to make the unit unusable. This becomes worse as the speed of operation increases.

The concluding article in this series will discuss the application of components to practical problems.

Gas Turbine Drives Truck

SUCCESSFUL preliminary road tests of the world's first gas turbine-powered truck, using the Boeing Airplane Co.'s experimental 175-hp, lightweight Model 502 turbine, have been completed. Trial runs of the new 200-pound Boeing power plant, under development for the U. S. Navy Bureau of Ships, have been conducted on a ten-ton trailer unit. The gas turbine is similar to the jet airplane engine in its general design, but the power developed is harnessed effectively by a secondary turbine to turn a shaft rather than being exhaused as jet thrust.

Contrary to public expectations, the new turbine-powered truck is considerably quieter than a conventional diesel truck of equal power. Exhaust gases are approximately the same temperature as those from a diesel or gasoline truck. At idling power, for instance, it is possible to place a hand over the end of the exhaust pipe without danger of being burned.

The turbine runs equally well on gasoline, kerosene, light or heavy fuel oil, and has been test run on "bottled" gas. Features of interest to truck and car operators include the elimination of a cooling system, the elimination of much gear shifting, the ability to start and immediately develop full power without the "warm-up" period common to piston type engines, and the impossibility of "stalling" the engine. The turbine weighs at least 2500 lb less than conventional engine installations of equal power. This weight reduction, combined with the fact that the turbine occupies only 13 per cent of the space normally taken by the conventional 200-hp gasoline or diesel engine, will make possible certain changes in truck design, such as improved accessibility.

Controls for the gas turbine truck differ only slightly from those of a conventional vehicle. Starting is accomplished by a standard automobile type starter, which brings the turbine up to idling speed. At this speed the fuel valve is turned on and the engine operates "on its own." A pedal is used for shifting from one gear to another, or for reversing. Speed is controlled with the usual foot throttle.

Transverse Vibration

. . . of loaded shafts where shaft weight must be considered

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VIBRATION calculations for rotating shafts require a knowledge of natural fundamental frequencies. When there is only a single concentrated mass and the shaft mass can be neglected, the simple beam formulas for load-deflection ratio furnish the necessary information. However, when the mass of the shaft is comparable with that of the load, a modifying factor must be included. This article presents a simple approach which, with the aid of two charts, provides a fast and accurate solution for any problem when shaft mass is appreciable.

THE PROBLEM: A typical system is shown in *Fig.* 1. The load on the shaft weighs W lb. The shaft itself weighs W_s lb, has length l inches, and is supported by two bearings, one at each end. The weight W is at a distance a inches from one end. Standard solution for the natural transverse frequency is

$$f_n = \frac{1}{2\pi}\sqrt{\frac{kg}{W}} \quad \ldots\ldots (1)$$

if the inertia of the shaft is neglected, and if no distortions of the load W or the bearings are assumed.

In Equation 1, f_n = natural frequency, cycles per second; k = spring constant of the shaft, lb per in; and g = gravitational acceleration = 386 in. per sec per sec. The spring constant k can be found from the standard formula for the deflection of a beam:

$$y_p = \frac{Pa^2b^2}{3EIl} \quad \ldots\ldots (2)$$

where y_p = deflection under load P; E = Young's modulus, psi; I = moment of inertia, in.^{4}; and a, b, and l are dimensions indicated in *Fig.* 2.

For $y_p = 1$, the arbitrary load P is the spring constant k. Hence,

$$k = \frac{3EIl}{a^2b^2} \quad \ldots\ldots (3)$$

If the shaft is heavy in comparison with the weight of the load, the natural frequency of transverse vibration can be given by the equation

$$f_n = \frac{1}{2\pi}\sqrt{\frac{kg}{W + RW_s}} \quad \ldots\ldots (4)$$

where R is a fraction, and RW_s is that part of the weight of the shaft which, when concentrated at the position of the load, is dynamically equivalent to the shaft.

Strictly speaking, the shaft and load system has an infinite number of degrees of freedom, because the shaft is a continuous elastic body. This system cannot be replaced exactly by an equivalent system of one degree of freedom, as is done in Equation 4. However, the equivalent system will give the lowest nat-

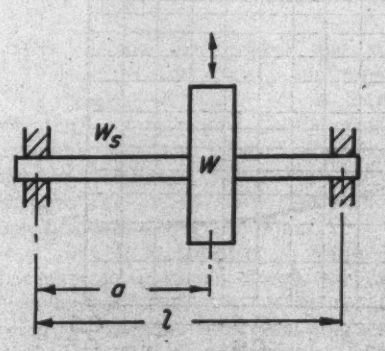


Fig. 1—Heavy rotor is shown mounted on a shaft subject to transverse vibration. Analysis presented here tells what fraction of the shaft mass may be considered to vibrate with the rotor. This information is necessary in calculating critical speed

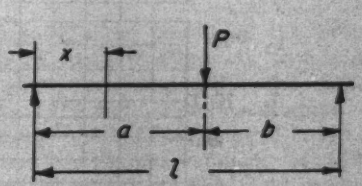


Fig. 2—Shaft deflection at any point (x) is calculated on the assumption that it is a simply supported beam carrying a concentrated load at a distance (a) from the left support

ural (fundamental) frequency accurately enough for all engineering purposes. The fundamental frequency is also by far the most important, as compared with the higher frequencies.

CALCULATION OF RATIO R: Referring to *Fig.* 2, the deflection of the shaft at any point is given by the equations

$$y = \frac{Pb}{6lEI}[x^3 - (l^2 - b^2)x] \quad (0 \rightarrow x \rightarrow a) \quad \ldots\ldots (5)$$

$$y = \frac{Pb}{6lEI}\left[x^3 - \frac{l}{b}(x-a)^3 - (l^2 - b^2)\,x\right]$$

$$(a \rightarrow x \rightarrow l) \quad \ldots\ldots (6)$$

where $b = l - a$; x is the variable distance measured from the left support; and y is the deflection from the horizontal, taken as negative downward. When $x = a$ both equations reduce to Equation 2.

When the shaft is vibrating transversely each point on it is in motion, hence the mass of the shaft has an effect on the dynamic behavior. The amplitude of this motion is approximately equal to the deflection given by Equations 5 and 6, within the limits of accuracy required for engineering purposes.

Purpose of the analysis which follows is to determine the maximum kinetic energy of the shaft when vibrating with amplitude given by Equations 5 and 6. Then it will be possible to determine what fraction of the shaft, concentrated at the same point as the load, will give the same kinetic energy. This fraction is the ratio R required in Equation 4.

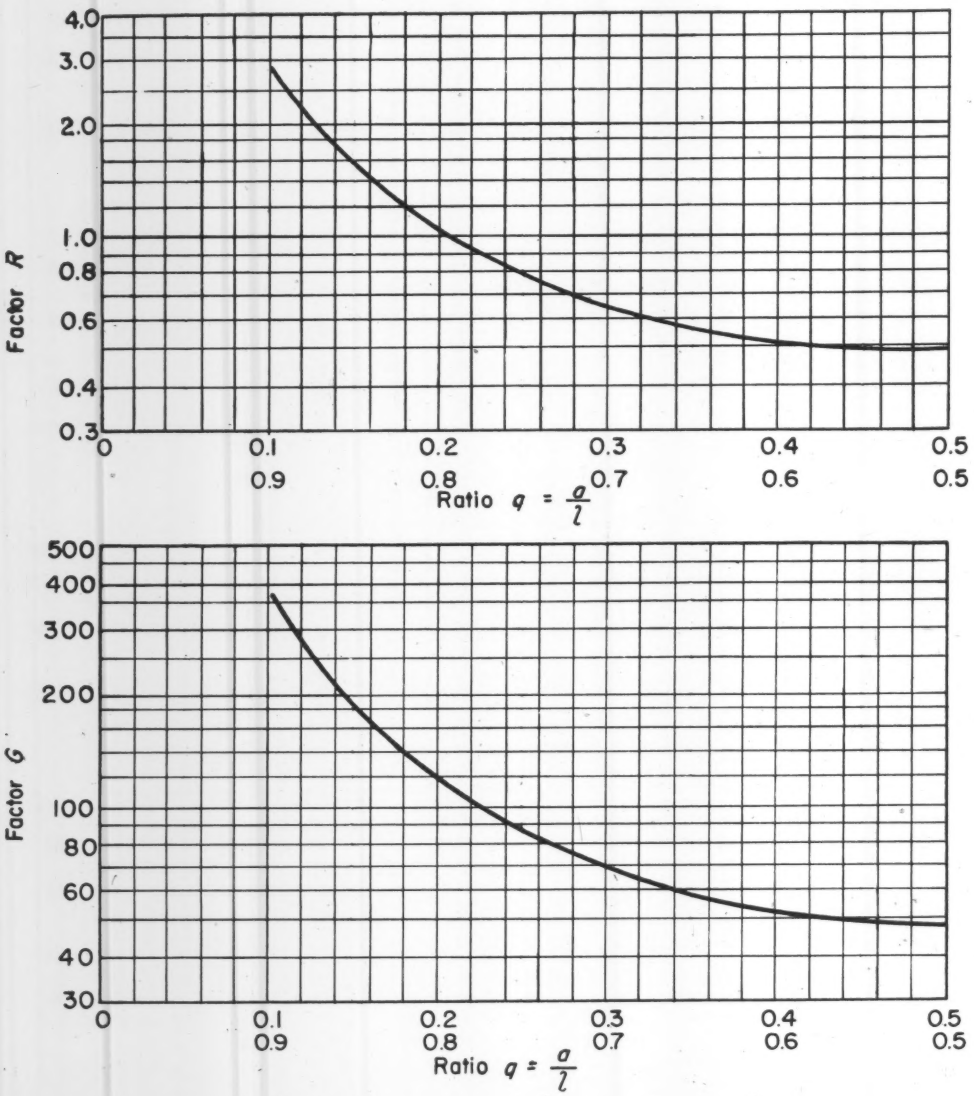
Considering the section of the shaft to the left of P, Equations 2 and 5 give

$$\frac{y}{y_p} = \frac{x^3 - (l^2 - b^2)x}{2a^2b}$$

The instantaneous velocity of the point x is

(*Continued on Page* 200)

Fig. 3—Chart gives values of (R) and (G) as functions of (q). Substituted in Equation 15, they permit quick calculation of fundamental frequency of transverse vibration

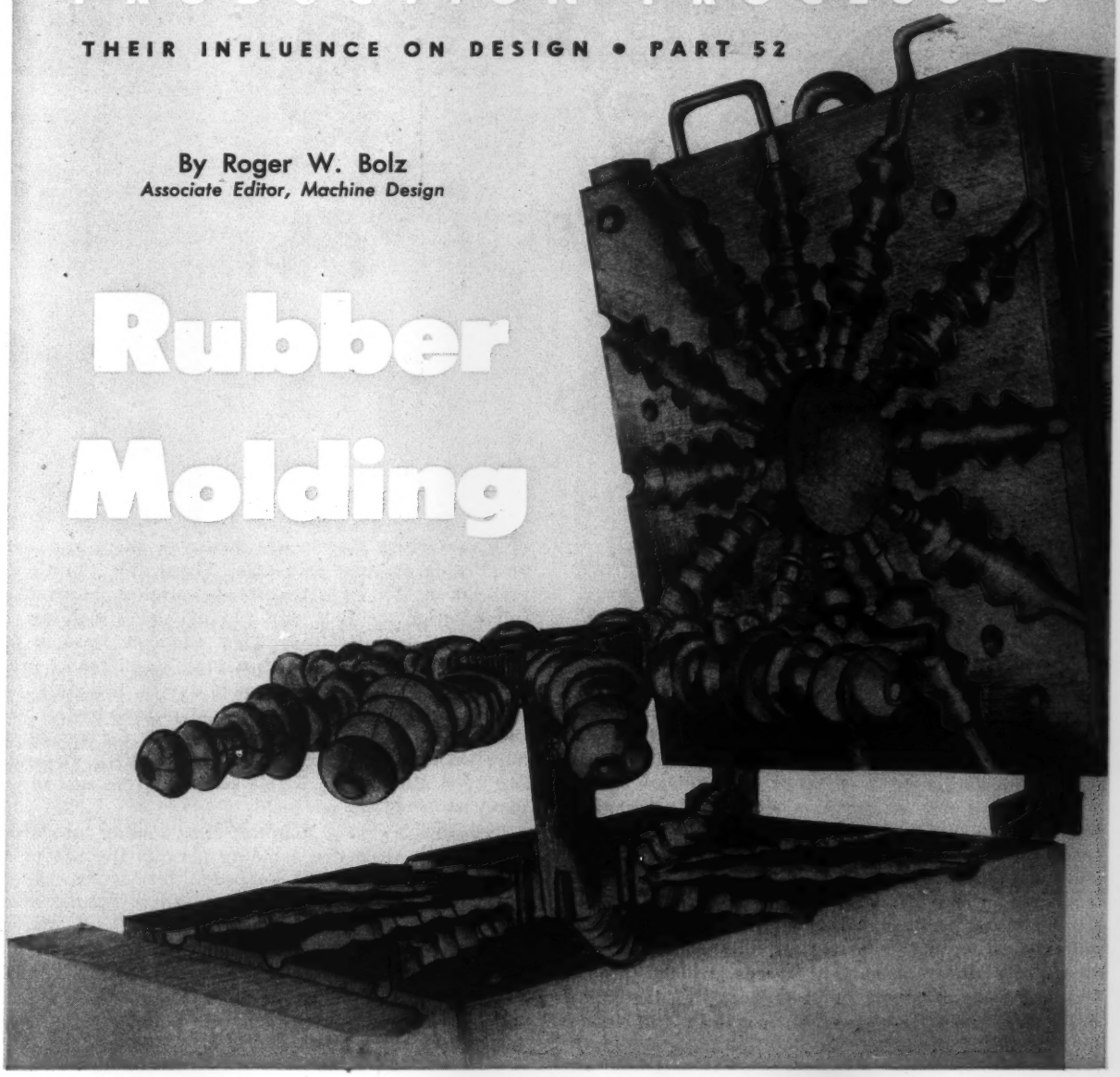


PRODUCTION PROCESSES

THEIR INFLUENCE ON DESIGN • PART 52

Rubber Molding

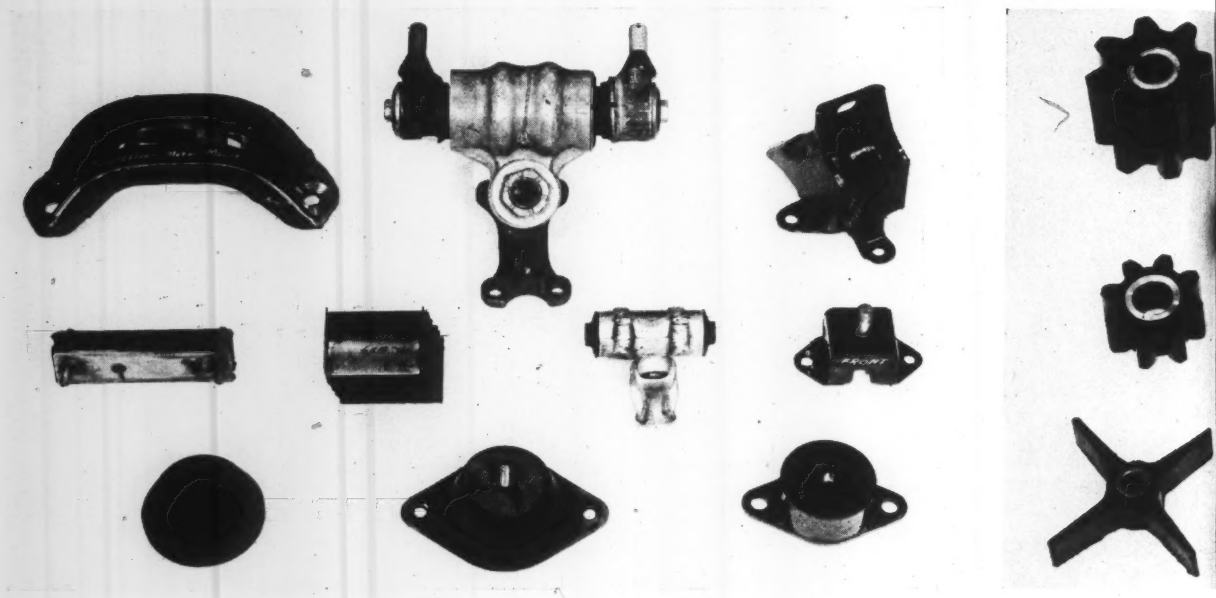
By Roger W. Bolz
Associate Editor, Machine Design



LIKE the plastics, rubber and rubberlike synthetics provide almost unlimited possibilities as component parts of machine assemblies. Again, it is a case where specific properties, largely unattainable with any other materials, *Fig.* 1, are a design necessity and some knowledge of rubbers, their advantages and limitations, and their manufacture into parts is invaluable.

As a rule, it is possible to design or redesign a rubber part to approach closely the ideal conditions for economical production without affecting or destroying the intended functional characteristics. However, the satisfactory designing of a rubber machine part, *Fig.* 2, requires a fair understanding of some of the properties of these materials, the problems of molding and of mold making. As with plastics materials, the particular compound to be employed has some effect on the method of manufacture which can be most readily used. Consequently, it is necessary to consider the various methods of molding which can be utilized and their individual design advantages and/or limitations.

RUBBERS: The rubber materials which can be utilized for molded parts now range from natural stocks from various areas to a full array of rubberlike synthetics. The crude or synthetic-base material is compounded with curing agents, antioxidants, accelerators, lubricants, etc., and thoroughly kneaded on



mixing mills. It emerges as large slabs for storage pending subsequent manufacturing operations. This "green" or uncured compounded rubber can vary from a soft gummy state to a hard leathery condition. In no case is it liquid.

The nature of this uncured stock determines largely just how it will have to be shaped or prepared to fit a mold cavity for proper flow. A soft compound can be roughly shaped and laid in or adjacent to the mold cavity, whereas a hard stock would require careful tailoring and placement directly in the cavity.

To obtain uncured stock of controlled size and shape for molding, therefore, the compounded material is processed by one of several preliminary operations: (1) Slabbing, (2) calendering, or (3) extruding (termed "tubing" in the rubber field). In slabbing, the compounded rubber is loaded into a mill, consisting of two large steel rolls which operate at slightly different surface speeds, which kneads and heats the compound and reduces its plasticity. After sufficient milling, the rubber is cut off in slabs, the gage of the stock being determined by the roll spacing. Cutting templates for "slabbing off" pieces to proper contour for mold loading are often employed.

The calender prepares the rubber compound in thin sheets which can be held to close tolerances. In calendering, *Fig.* 3, a ribbon of rubber is fed from a warmup mill to the calender rolls, from which it emerges as a sheet or strip. Rubberizing or "frictioning" of fabric is also done in a calender.

Extruding or tubing is carried out in a screw type extruder, shape and size of the stock being determined by the contour of the die. After cooling in a water tank, the extruded raw stock is cut to the necessary lengths for molding.

MOLDING METHODS: Oldest and still most widely used method for producing finished rubber parts is simple compression molding not unlike that utilized for plastics, *Fig.* 4. With some of the newer methods of manufacture now in use, however, there are four practicable molding processes. These are: (1) Compression molding, (2) transfer-injection molding, (3) full-injection molding, and (4) extrusion molding.

Compression Molding: This common method of molding consists in placing a piece or pieces of prepared stock in the heated mold cavity, bringing the halves of the mold together under pressure of 500 to 1000 psi, and curing, *Fig.* 5. Heat for curing is supplied by the platens of the press utilized. Depending upon size, it is possible to mold from one to as many as 360 pieces per mold.

Transfer-Injection Molding: Now coming into wide use, transfer-injection molding permits the use of a single piece of prepared compound. Intricately shaped parts can be molded with improved efficiency over the compression method. The prepared piece is placed in a charging cavity in the mold and forced at high pressure through runners or channels into the mold cavity, *Fig.* 6. Usually the mold is opened and closed by hydraulic pressure, a separate plunger being used for injection.

Full-Injection Molding: With this recent development in molding methods, an extrusion head is used as an integral part of the molding machine. Compounded rubber stock is fed directly into the extruder which, in turn, injects or forces the material into the mold cavity or cavities. These units, *Fig.* 7, are entirely automatic with the exception of stripping the finished parts from the mold.

Shorter Cure Period Used

Cavities are laid out so that the stock is injected into a central canal which branches into two or more feeders and thence to the cavities. High pressure and turbulence developed during injection result in high temperature, reducing materially the necessary curing period. Resultant savings in molding justifies the use of this equipment in many instances.

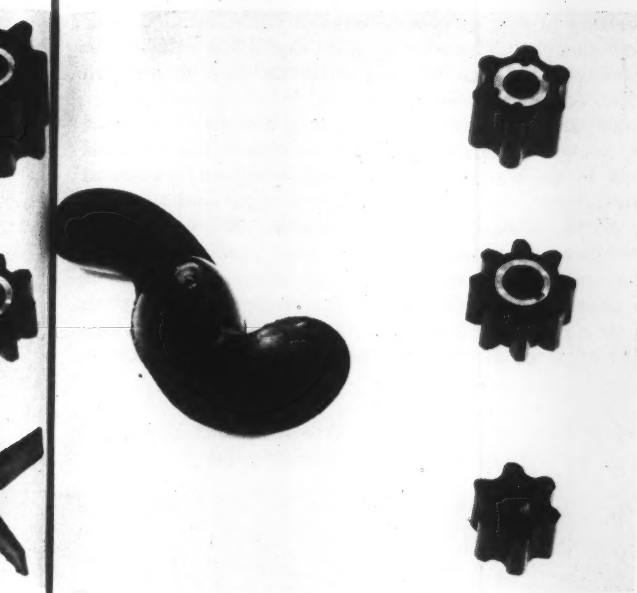


Fig. 1—Extreme left—Variety of rubber machine and engine mountings requiring special properties of resilience, tensile strength and low permanent set

Fig. 2—Left—Group of pump gears, impellers and a boat propeller made from oil and water-resistant Buna N synthetic rubbers

Fig. 3—Below—Sheeting out rubber on a calender

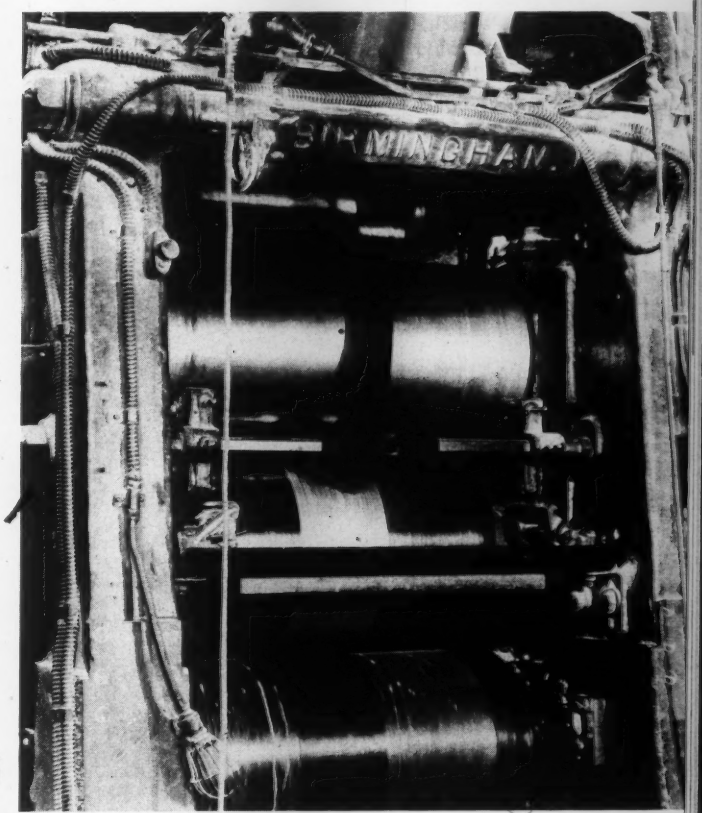


Fig. 4—Below—Following cure, a large pump impeller is removed from compression mold for finishing

Extrusion Molding: A wide variety of uniform cross section parts can be extruded rapidly to the desired shape. Very intricate sections are practicable. As mentioned, screw type feed is employed for forcing the stock through the die, *Fig.* 8. Unlike the other molding methods, extrusion does not permit curing during the cycle. After removal from the water cooling tank, extruded stock is cured under temperature and pressure by means of steam and after cooling, is cut to the necessary lengths.

Extrusions Limited to Six Inches

As a rule, extruded parts up to about 6 inches diameter are produced. Sections under 3/16-inch diameter can be extruded to lengths of about 500 feet, maximum. A tube of 6-inch diameter and $\frac{1}{8}$-inch wall, however, can only be produced in lengths to about 50 feet. Extruded shapes require fair volume production for economy inasmuch as it requires at least 100 pounds of stock to get an extruder into operation.

PRODUCTION CONSIDERATIONS: The final design of a molded rubber part normally represents a compromise between the desired end result and the economically feasible end result. Also important is the production quantity to be required. Lowest production cost will dictate one method for but few parts whereas another may be feasible for large quantity output.

DESIGN CONSIDERATIONS: Molded rubber parts require design technique somewhat different from that ordinarily found desirable with other methods of production. Four major points which must be kept in mind for economical design are: (1) Can a mold be made to produce the part economically?; (2) Can the mold be operated economically in production?; (3) Can the piece be finished economically?; and (4) Can the flash be removed without affecting the de-

signed function of the part? With these general factors under scrutiny at all times, minimum production cost and maximum satisfaction can be reasonably assured.

Parting Lines: As in all molding methods, placement of the mold parting or partings is extremely important not only for assuring simplest possible mold design and operation, but also for simplifying flash removal and finishing. Any particular location on a part which, for design purposes, should be free from flash should be so indicated on the drawing. Because nonfills result in rejects, molded rubber parts invariably have overflow flash and molds are designed to accommodate this condition, *Fig.* 9. Circular flash, such as in *Fig.* 9, is readily removable automatically and cheaply. The part at *a* in *Fig.* 10 is difficult to trim whereas that molded vertically as at *b* is much more economical.

Edges: Sharp or feather edges should be avoided in design inasmuch as they are difficult to mold and to trim accurately. The flat edge as shown at *b* in *Fig.* 11 is not only easier to mold and trim but is better looking. A sharp edge is difficult to hold to close tolerances and such mold portions wear to a rounded edge which causes poor sealing. In addition, a sharp edge would create the tendency to trap air in the mold and result in incomplete filling out. The flat edge, on the other hand, could be held to normal

Fig. 5—Cross section of compression mold and views showing mold loading and removal of cured parts

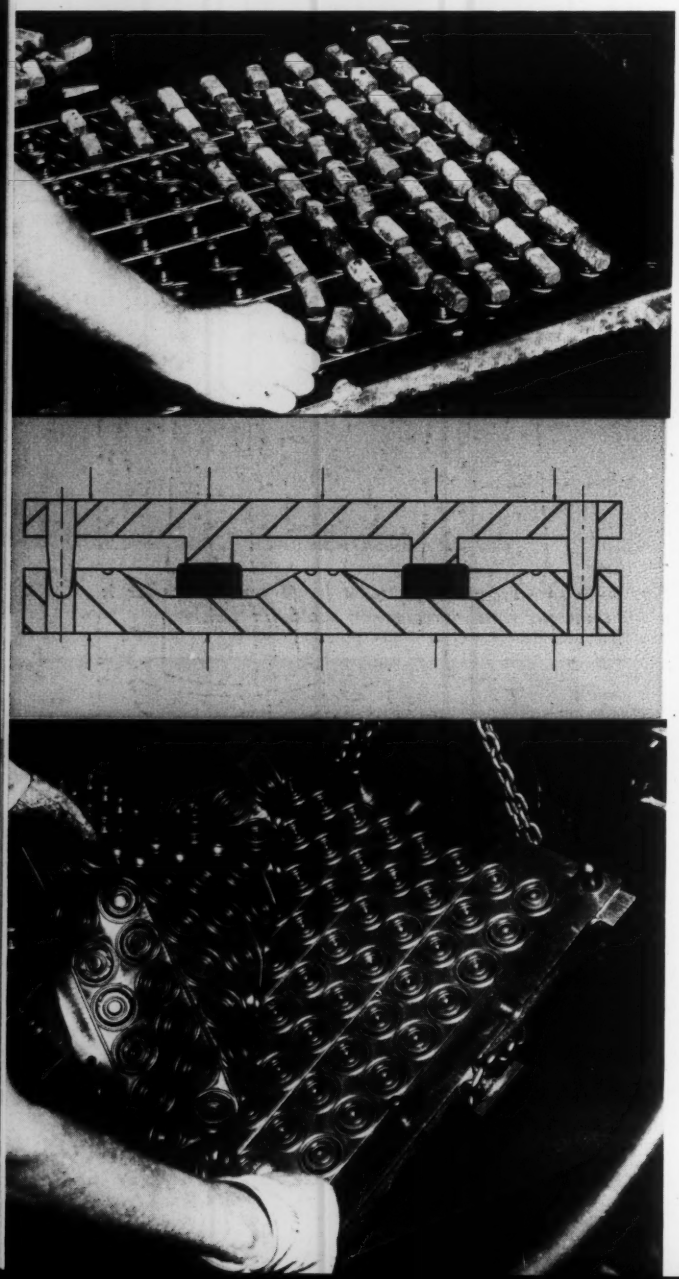
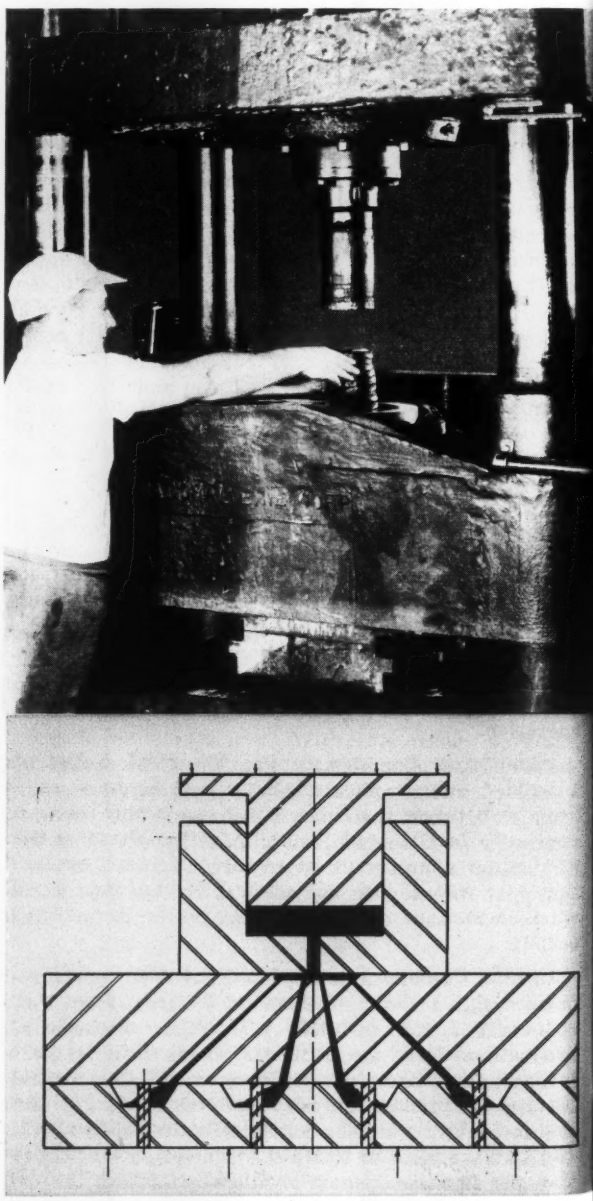


Fig. 6—View through a transfer-injection mold, below, and operator shown loading press



production molding tolerances indefinitely.

Corners: Rounded edges or corners must be used judiciously. Oftentimes, the use of a generously rounded edge makes it necessary to place the parting and flash line at a point which creates removal difficulties. Rounded edges, therefore, should be avoided at or near the parting. The sketch at *a* in *Fig.* 12 shows the flash line as dictated by a round edge. Unless the trim allowance on flash is generous, difficulty is encountered in removal operations. Where flash trim must be held to a few thousandths, the design with a square corner as at *b* in *Fig.* 12 is preferable.

Where edges are not at or near the parting line of the mold, rounded corners are the preferred design. As great a radius on corners, *Fig.* 13*a*, as possible will help improve compound flow in the mold and eliminate air trapping, characteristics generally present in molding sharp corners, *Fig.* 13*b*. This is particularly true in molding soft compounds.

Holes: Where holes through parts are along the major parting line necessary for molding, mandrels or core pieces are utilized. These must be so located that both molding of the piece and locating and removal of the mandrels are practicable, *Fig.* 14. Wherever possible, the diameter-to-length ratio of holes should be kept low. Pressures in molding are high and if mandrels or cores are too slender, sup-

Fig. 7—Screw type injection molding press and cross section through extrusion head and dies

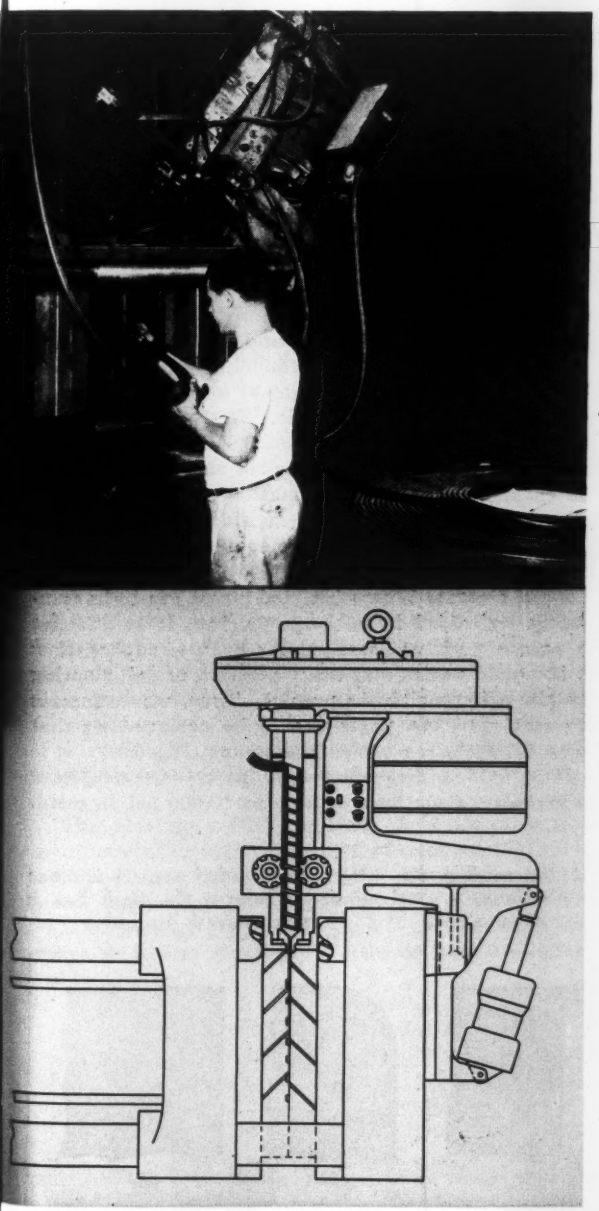
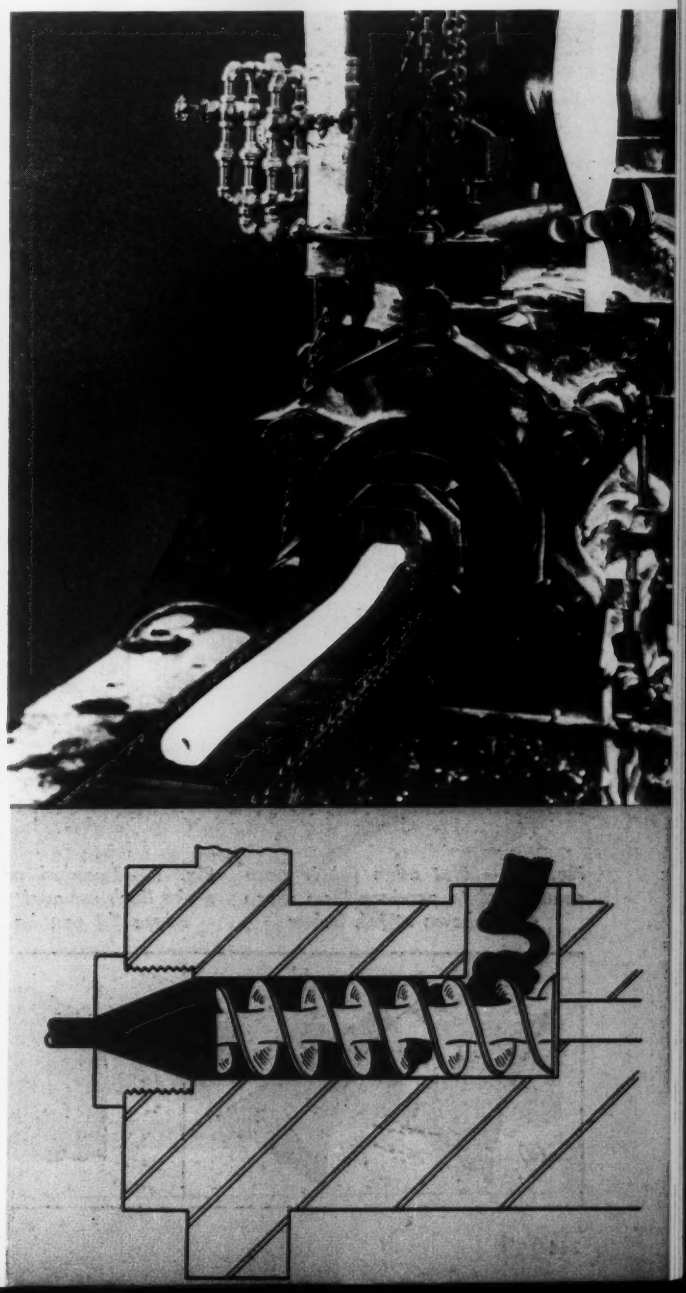


Fig. 8—Extruder producing a roll covering section and view through head and die



port pins are necessary to keep the core centered. Such supports, however, leave holes which require filling. Where holes are required for attaching molded rubber parts to other members, adequate spacing is necessary. Holes should be spaced generously from each other and also as far from edges as possible to eliminate tearing.

Undercuts: Re-entrant curves and deep undercuts create problems in molding. The undercut shown at *a* in *Fig.* 15 would be difficult to remove from the mold owing to the extreme difference in diameters on the core or mandrel pin. Furthermore, dimensions as at the small diameter *Fig.* 15*a,* are difficult to maintain because of extreme distortion and set during removal. To eliminate these problems and avoid possible tearing of the parts at the inner sharp corner, a design modification such as shown at *b, Fig.* 15, is recommended. This part would be much stronger and much more economical to produce.

Undercuts can be formed with solid mandrels or cores, as in *Fig.* 9, only where an elastic stock is used. Where compounds having low-stretch properties are required, cores or mandrels of the collapsing type must be used. Molding is much slower in such instances and consequently more expensive. Thus, when a rubber over 80 durometer hardness is specified undercuts should be avoided for economy. A design such as that shown in *Fig.* 10*b* could not be successfully produced in a horizontal mold using a low tear resistance stock.

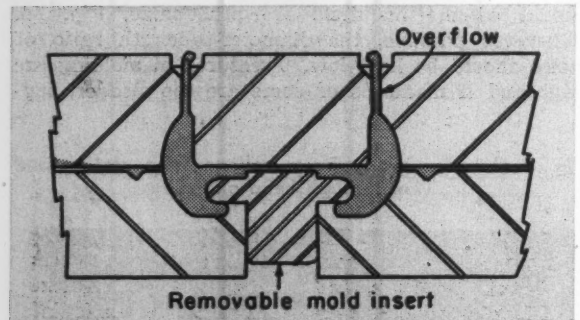
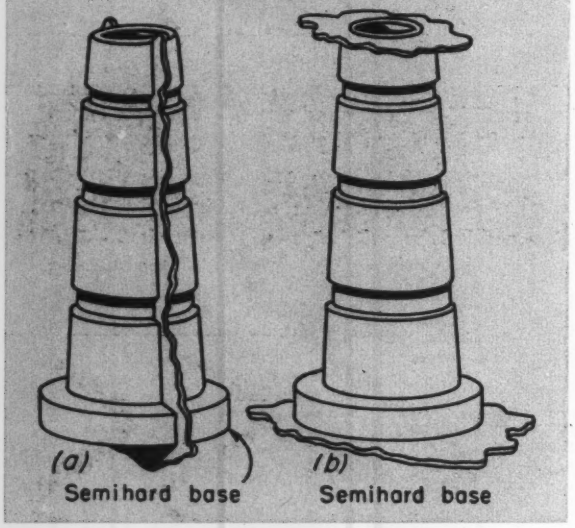


Fig. 9—Above—Cross section through dies showing flash and overflow. Part is inflation cup cap for milking machine

Fig. 10 — Below — Chicken picker machine finger molded horizontally at (a) and vertically at (b). Soft rubber makes possible mold at (b) and lower cost flash removal



Deep Slots Uneconomical

Deep, narrow undercuts should be avoided, not only because of difficulty in removal from the mold but because of the weakness of the mold projection needed to form the undercut. Mold repair costs are excessive with such designs. Depth of undercut should never exceed twice the width, *Fig.* 16, and width should be at least 1/16-inch and preferably greater.

Convolutions: Parts with convolutions having very thin walls and sharp corners as at *a* in *Fig.* 17 should be avoided whenever possible. Wall thickness with convolutions should be at least 0.050-inch or greater and as great a radius as possible should be used on the corners, *Fig.* 17*b.* Elimination of the sharp corners will improve flex life considerably and sufficient wall thickness allows for some shift of the mold mandrel.

Metal Inserts: Where inserted pieces are to be completely embedded in rubber, *Fig.* 18*a,* it is difficult to assure positive location. As a rule, rubber flow in the mold varies and exact position of full floating inserts is impossible to predict. Thus, where inserts are employed the parts should be designed so that the mold assures positive positioning, *Fig.* 19.

It is well to remember that inserts are subjected to pressure, sometimes as high as 10,000 psi, in mold-

Fig. 11 — Flat edge (b) is more economical to produce than sharp edge shown at (a), below

Fig. 12—Rounded edges at the parting (a) make flash removal expensive whereas square edges (b) can be removed economically

Fig. 13—Rounded corners improve design wherever the flash line is not involved, (a), below

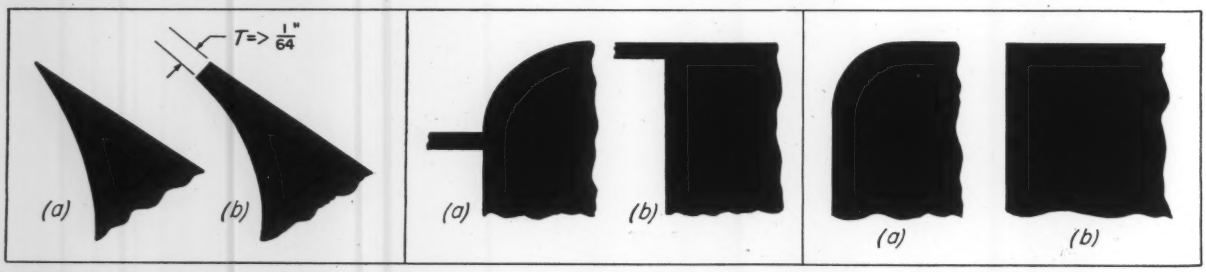
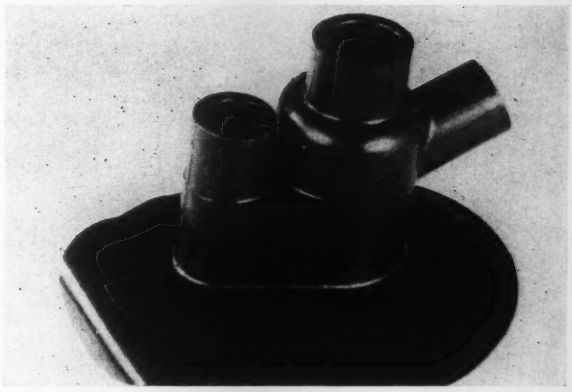


Fig. 14—Right—Aircraft fuel cell fitting which required a split cavity mold with a loose and permanent insert



ing and must be capable of withstanding such a load without deformation. Inserts must resist collapse and be such that displacement in molding is not possible.

Where rubber is to be molded into a metal shell of cylindrical or cup design, it is well to remember that parts having the rubber flush with the metal as at *b* in *Fig.* 18 are difficult to trim and clean. The rubber should be extended beyond the shell in all instances as at *c* in *Fig.* 18 to overcome these objections. In addition, if a perfectly flat end face or faces are desirable, the extension makes sufficient compound available for grinding. End faces are usually concave after molding owing to shrinkage and grinding is often desirable.

For best adhesion on metal inserts or attachments the surface should be smooth. Corrugations, serrations, knurling, etc., decrease the effective adhesion and should be avoided. Rubber to metal adhesion strength of 250 psi can normally be expected under average manufacturing conditions. Where rubber-metal parts are being designed for stressed applications, other important factors must be considered* which are beyond the scope of production design.

Where rubber parts are fastened to metal it is essential that chafing does not occur at the areas of contact. All flexing or distortion should occur in the main body of the rubber. A general rule of thumb to follow in designing for deflection is to provide a column of rubber at least four times the extent of movement. Thus, for ½-inch of flexing, a column of rubber not less than 2 inches should be provided.

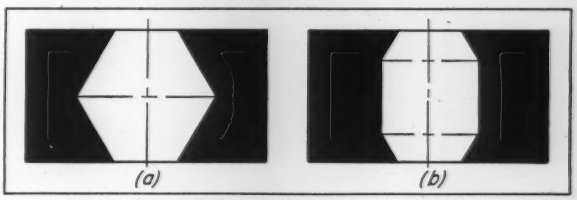
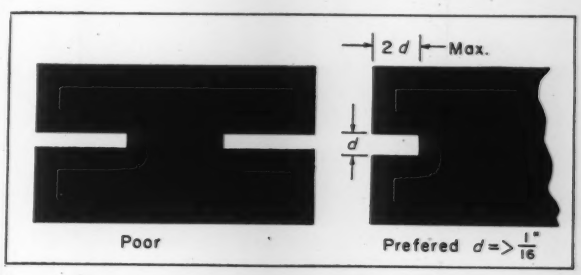


Fig. 15—Above—Undercut design (a) creates problems of tearing and distortion which are avoided by design (b)

Fig. 16—Below—Narrow, deep undercuts are poor design. Proportions should never exceed those indicated



Harder Varieties Require Draft

Draft: Where rubber of 90 to 95 durometer hardness is to be molded, it is good practice to allow a slight draft on all surfaces normal to the parting.

SELECTION OF MATERIALS: Natural rubber compounds are made from various natural crudes and can be formulated to give good tensile strength and elongation over their complete range of hardness. For resilience or elasticity, natural rubbers are relatively unexcelled by any of the synthetics so far developed.

The elastomer GRS or Buna S is an all-purpose synthetic used for the bulk of present synthetic rubber products. Relatively inexpensive, it has fairly good mechanical properties with the exception of tensile strength which is about one-tenth and resiliency which is about two-thirds that of natural rubber.

Apart from the foregoing so-called oil-soluble rubbers are those known as the oil-resistant group. These latter are of special importance where most machine parts are concerned. Each type has peculiar characteristics and no one will meet all requirements.

Thiokol identifies the organic polysulfide types

Fig. 17—Right — Sharp corners (a) on convolutions are detrimental to flex life and design (b) is preferable

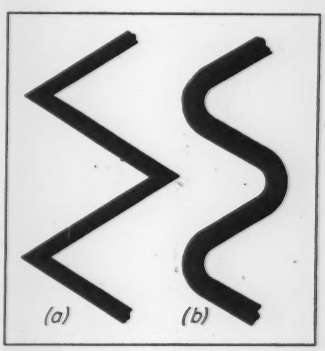
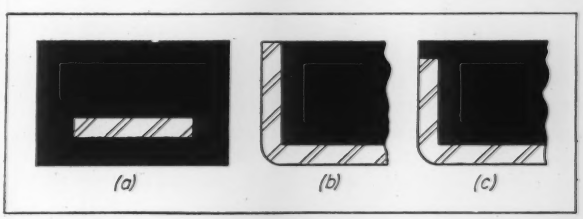


Fig. 18—Below—Totally embedded metal inserts (a) are difficult to position. Design (b) is difficult to trim and (c) is preferred for economy



* "Design Data on Natural and Synthetic Rubbers for Mechanical Engineers" by E. F. Riesing, presented at the Annual Meeting of ASME in New York, Dec. 1949.

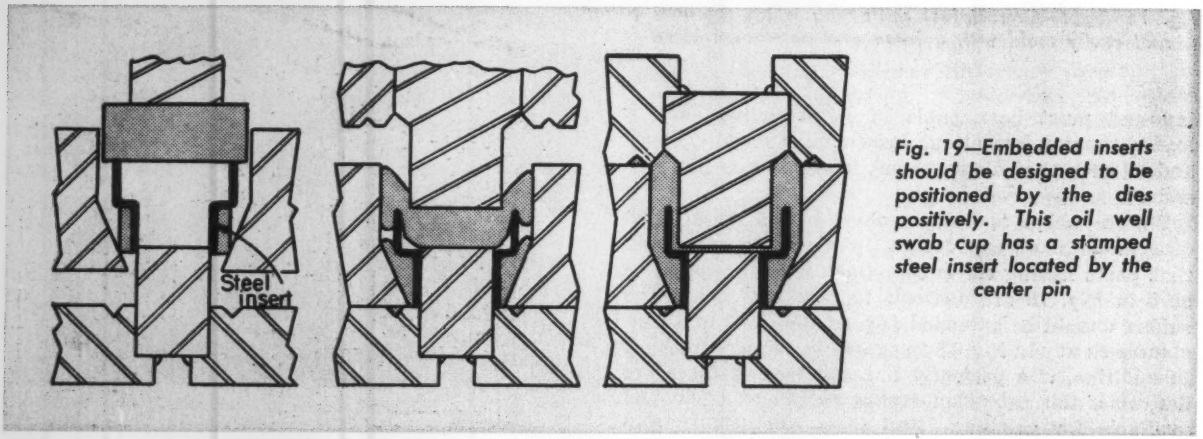


Fig. 19—Embedded inserts should be designed to be positioned by the dies positively. This oil well swab cup has a stamped steel insert located by the center pin

having a fairly wide range of durometer hardnesses. These compounds are practically unaffected by gasoline, fuel oils, kerosene, lubricating oils, dilute acids, or alkalis. Benzol causes some swelling. Thiokol FA offers poor cold flow properties. However, the newer ST type eliminates this problem and offers excellent low-temperature flexibility. Flexibility is retained to minus 65 F.

Neoprenes are higher swelling elastomers than Thiokol or Buna N. The compounds are flameproof and offer excellent resistance to temperatures up to 250 F. Stable under severe flexing and resistant to sunlight or ozone, these elastomers may be used with gasoline, oils, air, natural or manufactured gases, weak acids, and alkalis. Flexibility to minus 40 F and occasionally lower may be had. Type GN is somewhat more resilient than type E but is a little more difficult to process. Special type FR can be compounded for operating conditions down to minus 70 F or lower. Tensile strength and water resistance of FR, however, is lower and swelling in oils and solvents slightly higher than that of the other two types.

Table 1—Processing Characteristics of Rubber and Synthetics

Material	Mixing Eff.	Extruding	Calendering	Cohesion	Molding
Natural	100	100	100	Excellent	Excellent
Buna S GRS	85	90	90	Fair	Fair
Buna N GRA	50	50	50	Poor	Fair to Excellent
Butyl GRI	90	90	100	Good	Good
Thiokol GRP	75	75	50	Poor	Good
Neoprene GRM	100	75	90	Good	Good

Buna N includes several types which vary only slightly in characteristics. Excellent resistance to mineral oils, animal oils, fats, vegetable oils, some solvents, gasses, and water are typical. Resiliency is similar to that of Buna S. Benzol, toluol and carbontetrachloride cause considerable swelling but no deterioration. Resistance to high temperatures (225 F), compression set and abrasion is excellent also. Flexibility to minus 65 F may be had with some types. Compounds may be produced ranging from extremely soft to bone hard and the material will not flow even under extreme pressures, *Fig.* 20.

Silicone rubber synthetics have poor common properties such as tensile strength, elongation at break, and resistance to abrasion compared to natural and other synthetics. They do have, however, the important property of resistance to extreme heat, the useful range is from minus 1000 F to 500 F. They retain flexibility, resiliency and hardness for long periods, have low compression set and favorable electrical properties. The material has no tendency to stick or adhere to metallic surfaces. It does not deteriorate in oil but does in gasoline. Cellular silicone rubber, Cohrlastic, is also available for use in vibration dampers, fairing, seals, gaskets, etc.

A new synthetic, Enrup, has a variety of forms ranging from elastic to rigid with outstanding impact strength, *Fig.* 22. It is expected to help fill the wide gap between the softer range of rubbers and synthetics covered in this article and the hard rubber (thermosetting plastic) mentioned in the previous discussion, Part 51.

Drawing Specifications Important

In the design of any rubber part it is necessary to specify the desired compound properly. ASTM specifications should be used for adequate interpretation of requirements to the parts manufacturer. Mechanical rubber specifications may be had in ASTM Specification D735-46T and those for cellular rubber from ASTM Specification D798-46aT.

In the case of cellular rubber parts, *Fig.* 21, density or compression should be specified. Also, it should be determined whether a mechanical skin is desired on cellular rubber parts. Color must be noted or the common black or gray will be assumed. Any special finish must be noted on the drawings. Average machined mold finish is commercial and any other usually results in increased expense. General comparative processing characteristics of rubbers are given in TABLE 1.

TOLERANCES IN PRODUCTION: In the design of molded parts, adequate consideration should be given to dimensional tolerances inasmuch as these directly af-

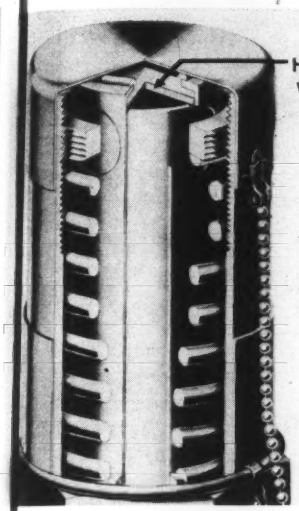


Fig. 20—Left—Propane relief valve with Hycar synthetic seat. Material will not adhere to metal and pressure setting remains constant in service

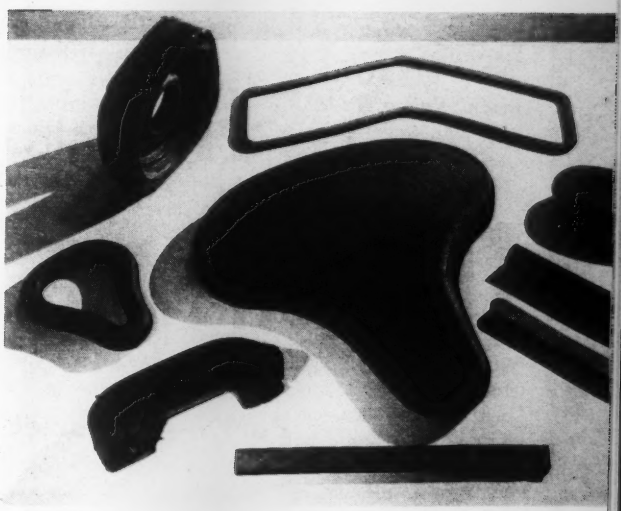


Fig. 21—Right — Group of molded cellular parts including a motor mount, vibration damper, motorcycle seat, and various machine gaskets

fect cost. A good minimum dimensional tolerance for small parts is plus or minus 0.010-inch although plus or minus 0.005-inch can be held commercially. If, for instance, a 1-inch diameter by ¼-inch disk was to be molded to plus or minus 0.005-inch on diameter and thickness, a 100-cavity mold could be used. Were this tolerance reduced to plus or minus 0.003-inch, however, a smaller mold with 16 to 25 cavities of much greater cost would be necessary and parts cost would be greatly increased.

Applicable tolerances generally must vary according to size, and the usually accepted tolerance on dimensions *not* affected by flash is plus or minus ½ per cent. The tolerance on dimensions perpendicular to the flash plane are as follows:

0 to ½-in. incl.	±0.010-in.
½ to 1 in. incl.	±0.015-in.
1 to 2 in. incl.	±0.031-in.
2 to 3 in. incl.	±0.046-in.

The allowable variations in wall thickness as indicated by runout on cylindrical or circular parts are generally as follows:

0 to 2½-in. diams.	0.020-in. total ind. reading
2½ to 5-in. diams.	0.031-in. total ind. reading
5 to 10-in. diams.	0.062-in. total ind. reading

Established tolerances on dimensions of special extruded shapes are:

0 to ¼-in. incl.	±0.015-in.
¼ to ½ in. incl.	±0.031-in.
½ to 1 in. incl.	±0.046-in.
1 to 2 in. incl.	±0.062-in.

After a rubber part is removed from the mold, shrinkage takes place on cooling to the extent of ½ to 4 per cent depending upon the stock and part shape. These variations make it expensive to obtain closer tolerances on parts than those indicated in the foregoing. However, it can be done but at higher cost.

Where a part is to be made from a soft grade of material and stretching or contracting is needed to remove the finished pieces from the cavities, an additional allowance must be made for hot distortion. Where shear or compression rates are specified, a tolerance of plus or minus 15 per cent is required to allow for variations in rubber modulus, metal dimensions, and testing discrepancies.

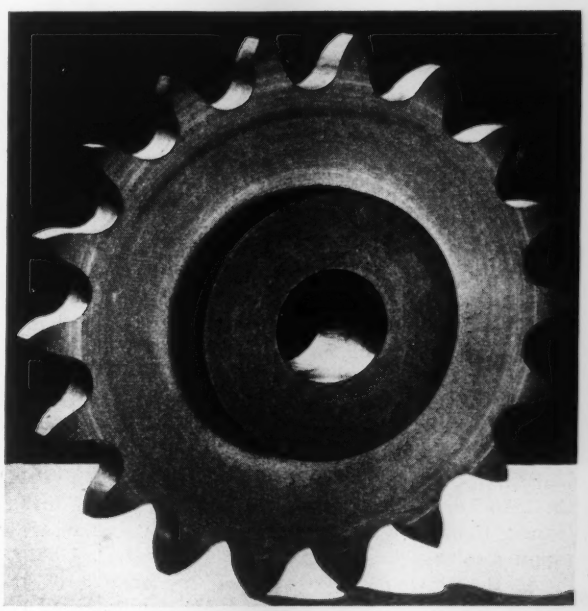


Fig. 22—Sprocket wheel molded from Enrup has exceptional abrasion resistance and requires no center bearing

Typical tolerances on dimensions of cellular rubber products are given at the end of ASTM Specification D798-46aT.

Collaboration of the following organizations in the preparation of this article is acknowledged with much appreciation:

Connecticut Hard Rubber Co. . . . . New Haven, Conn.
Gates Rubber Co. (*Figs.* 9, 10) . . . . . Denver, Colo.
B. F. Goodrich Chemical Co. (*Fig.* 20) . . . Cleveland, Ohio
Goodyear Tire & Rubber Co. (*Figs.* 1, 2, 3, 4, 5, 6, 7, 8 and 14) . . . . . Akron, Ohio
Ohio Rubber Co. . . . . Willoughby, Ohio
Sirvene Div., Chicago Rawhide Mfg. Co. (*Figs.* 11, 12, 13, 15, 16, 17, 18 and 19) . . . . . Chicago, Ill.
Sponge Rubber Products Co. (*Fig.* 21) . . . Shelton, Conn.
U. S. Rubber Co. (*Fig.* 22) . . . . . New York, N. Y.

Highlights in the History of

MACHINE HYDRAULICS

Part 7—Servomechanisms and Hydraulic Motors

By H. G. Conway
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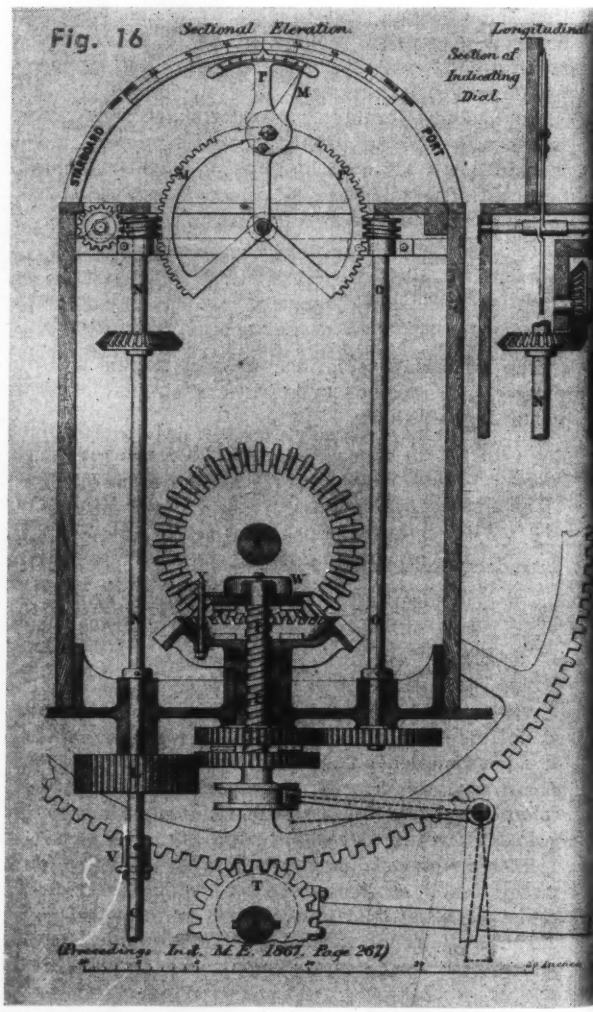
Gloucester, England

IT IS NOT clear who invented the first servomechanism. According to Reuleaux in *The Constructor* (1894) the earliest known use of such a mechanism is in a rotary steering gear designed by T. E. Sickles of Providence, Rhode Island. This gentleman appears to have made his first application of the mechanism in 1849, his patent being granted in 1860 and his first machine exhibited at the London Exhibition of 1862. It is known that the rotary servo preceded the simpler lever follow-up gear. A book *Le Servo Moteur ou Moteur-Asservi,* published in Paris in 1873 by J. Farcot, claims for its author the invention of numerous now well known variants which were applied to ship steering gear.

A. B. Brown's servo steering mechanism of the famous *Great Eastern* ship (1867) is illustrated in *Fig.* 16. This was steam operated, not hydraulic, but is of interest as a very early rotary follow-up mechanism. The differential mechanism consisted of a screw and a nut which when rotated differentially caused a translation of the screw relative to the unit.

The pilot turns the shaft *N* through the small bevel gear. The wide gear *L* meshes with a similar but narrower gear fixed to a shaft *I* carrying a coarse thread and screwed into a nut formed in the bevel *J*. This bevel meshes with another on the shaft *K,* connected to the steam steering engine and the rudder. Initial rotation of the steering wheel causes the screw to translate in the nut as it rotates, due to the coarse thread or helix. This translation moves a flanged collar which in turn moves a lever connected to the steam valve.

Thus the follow-up action arises from the translation which occurs when screw and nut rotate relative to one another, the steam being admitted to move the engine to preserve the appropriate angular relation-



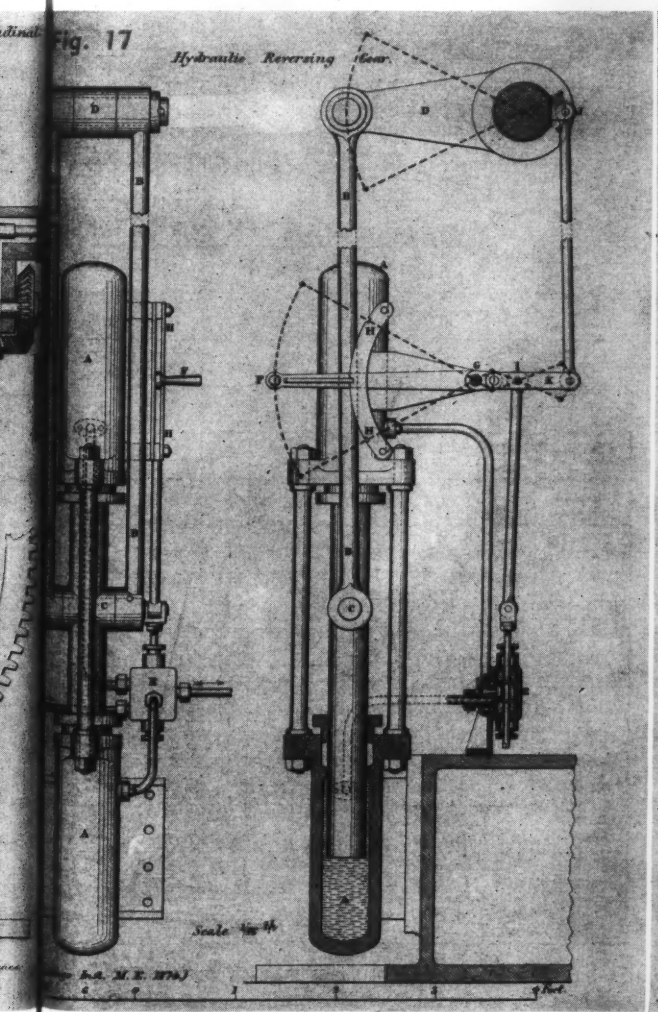
ship. To avoid jamming of the screw in the nut at full stroke in either direction, projecting clutch dogs are used at either end of the screw between its end faces and the bevel gear faces. A pointer indicates the position of the rudder, the pointer sector being in two parts, one part being connected to the rudder, the other to the helm. A secondary pointer between the two parts of the sector indicates the position of the helm in relation to the rudder (i.e., the position of the servo valve).

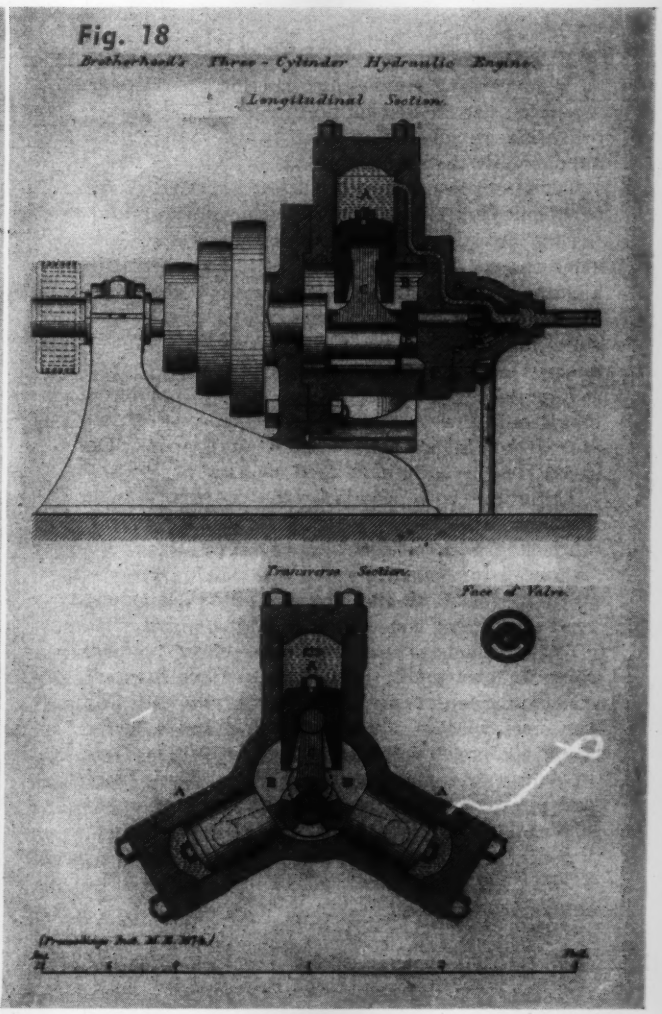
By 1874 hydraulic power was widely used on shipboard for a variety of duties and in that year was described the interesting lever type of servo mechanism shown in *Fig.* 17, the lever principle having been patented by Brown in 1870. To anyone with a knowledge of the type of servo booster used on modern aircraft, this illustration will be of particular interest; in fact, some of the modern designs compare unfavorably with it as to simplicity of conception and execution.

The hydraulic jack or cylinder consists of two plunger units connected together. It was presumably much easier to make accurately an external cylindrical surface than an internal surface and the construction shown was neat and simple if rather long. The usual four-way hydraulic valve was connected to the control lever and by means of follow-up gear to the reversing shaft. The lever was of the usual differential type which allowed close reproduction of motion between the control lever and the shaft.

Between 1850 and 1900 many high-pressure rotary motors were built for operating winches, turntables, etc., at dock yards and railway stations. The Brotherhood motor of 1874 shown in *Fig.* 18 is an example worth illustrating.

The engine is of the three-cylinder radial type, the detail design of the connecting rods, which were stated to be machined in a unit and subsequently split, being particularly neat. It will be noted that simple circular rings are used on each end of the crank pin to retain the connecting rods. The valve gear consisted of a rotary disk valve, provided with a balancing diameter to reduce the unsupported load between the valve and the casing of the pump. It was stated that no difficulty was experienced with this component once the correct degree of balancing had been determined, and the whole machine appears to have worked reliably. Originally the valve face was cast iron but later a lignum vitae insert was used.





Charts Simplify Calculations

Part 3—Turning and Boring

By Tyler G. Hicks
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Summit, N. Y.

BASIC among production methods are those concerning single-point cutting operations. For use in determining the time required to finish various lengths of work, this chart supplements the preceding ones.

TURNING, BORING AND CUTTING: The chart accompanying is useful not only for turning and boring, but also for flange and plate work. Besides the cutting time, such factors as work diameter, length, cutting speed, and feed can be found by use of this intersection chart. The solid lines shown are for single cuts and the dashed lines are for two successive cuts.

Example: How long will it take to make a single cut on a brass member 6 inches in diameter and 9 inches long when a 40 fpm cutting speed and a 1/32-inch feed is used?

Enter the bottom side of the chart at 6-inch diameter and project vertically to the 9-inch work length line. From here project horizontally to the 40 fpm cutting speed line and then vertically to the 1/32-inch feed line. At the right read the cutting time as 11.3 minutes.

When cutting speed exceeds chart values, solve the problem by projecting to a speed which can be divided evenly into the actual speed. For instance, with a 200 fpm cutting speed, solve using 50 fpm and then divide the result by four to obtain the actual cutting time. For flange and plate work use the mean diameter when entering the chart. Chart is based on

$$C = 3.1416\ DL/12SF$$

where C = cutting time, minutes
D = Work diameter, inches
L = Work length, inches
S = Cutting speed, feet per minute
F = Feed, inches

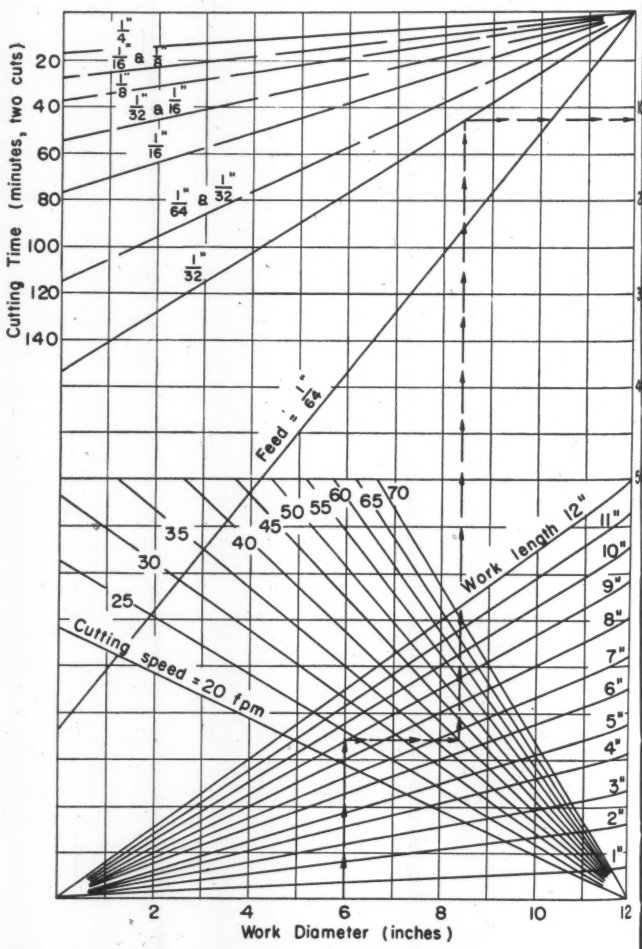

Fig. 1 — Testing machine as set up for operation with sliding follower. Cam is at center, directly below driving belt, with the flywheel visible below the cam. Vertical accelerometer beam and velocity-measuring device are at the left in the photograph

Cam Follower Dynamics

Tests show the cycloidal cam profile to result in lower peak and oscillatory forces than parabolic and harmonic types

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A CONTROVERSY has existed for some time over which of three commonly used cam profiles would provide the most desirable follower motion in cases where that motion is not prescribed by the requirements of the machine of which the cam is a part. The three profiles in question are curves of parabolic, harmonic, and cycloidal form. A desirable follower motion is one which requires minimum time, provides smooth acceleration and deceleration of parts, and provides positive, accurately-controlled motion. This motion should be produced by a cam which is inexpensive to make and which requires a minimum of maintenance.

The controversy has been concerned with the accelerations and related forces produced in a cam-and-follower system by each of the profiles in question.

From a paper presented at the ASME Spring Meeting, Washington, D. C., April 12-14, 1950.

In the past, one school of thought held that accelerations should be kept to a minimum at all times, in order to keep forces low, and, since the parabolic profile provides the lowest over-all theoretical acceleration value of the three, it has become a very popular profile. The theoretical peak acceleration for the parabolic profile is only 81 per cent of that for the harmonic and 64 per cent of that for the cycloidal profile. These facts have been a powerful argument in favor of the parabolic curve, but that argument neglects completely any effects which might be introduced into a cam-and-follower system by the *rate* at which acceleration, and corresponding force, are applied to that system. This argument has been carried on in spite of the fact that with constant acceleration and deceleration characteristics, the loads must be applied and removed instantaneously. If follows that the resulting peak forces must be influenced by

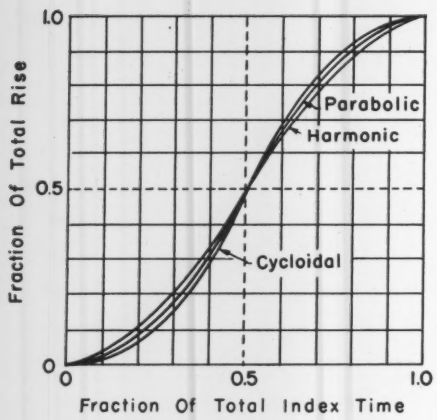
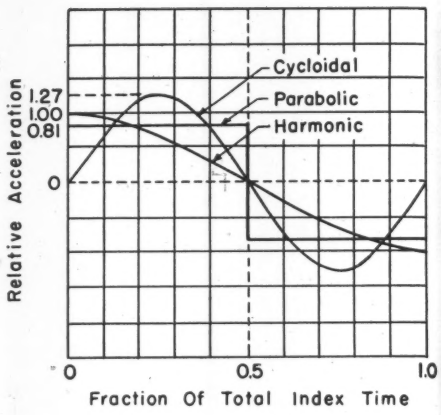


Fig. 2 — Left — Theoretical curves of follower diplacement versus time for parabolic, harmonic and cycloidal cams

Fig. 3—Right — Theoretical curves of follower acceleration versus time for the three cam types



the sudden application, reversal, or removal of operating forces.

The harmonic profile has an advantage, in that its maximum pressure angle is smaller than that of either of the other profiles. The cycloidal contour has no such obvious advantages. It has a sinusoidal acceleration curve which, up until fairly recently, has received only a small amount of attention. The literature on the subject of cam profiles has confined itself almost exclusively to the advantages of the parabolic or harmonic type of profile, and only recently have investigators made further analyses, based upon the effects of rate of application of acceleration, and system elasticity, a factor which had always been neglected.

DESCRIPTION OF TESTS: Tests were made with parabolic, harmonic, and cycloidal cams under identical test conditions, *Fig.* 1. The cams were of the internal-groove plate type, made of cast iron, and were run with hardened steel rollers 1⅛ inches in diameter. The finished cams were measured so that profile and track-width variations would be known. The tolerances achieved averaged less than plus or minus 0.001-inch, with maximum values of plus or minus 0.0015-inch. All three cams had a 2-inch rise, 70 degree angle of rise, and 70 degree angle of fall, with two 110-degree dwell portions. They were so calculated that the harmonic cam would have a maximum pressure angle of 30 degrees. Maximum centerline radius in all cases was 6.657-inches. The cams were run with both a swinging and a sliding follower system. Forces exerted on the follower were measured by means of electrical strain gages, the output from which was fed into a Brush strain analyzer and recording oscillograph.

Tests Performed

Tests were made on all three cams at fixed speed from 20 to 170 rpm, and with follower natural frequencies of 20 to 162.5 cycles per second. In addition to these tests, two others were performed as explained in the following:

1. With swinging follower natural frequency of 50.3 cps, the speed was varied from the maximum at which the cams could be operated down to zero. Continuous force-time plots were made, and the speeds at which the follower system came into resonance were noted.
2. With sliding follower natural frequency of 36.5 cps, the speed was varied as before. Continuous force-time and velocity-time plots were made, resonance points were noted.

The time-displacement equations for the three cam curves considered are as follows:

Parabolic,

$$\frac{X_f}{L} = 2\left(\frac{\theta}{\theta_0}\right)^2$$

Harmonic,

$$\frac{X_f}{L} = \frac{1}{2}\left(1 - \cos\frac{\pi\theta}{\theta_0}\right)$$

Cycloidal,

$$\frac{X_f}{L} = \frac{1}{\pi}\left(\frac{\pi\theta}{\theta_0} - \frac{1}{2}\sin\frac{2\pi\theta}{\theta_0}\right)$$

where X_f = Displacement of cam follower
L = Total cam rise
θ = Angular displacement of cam
θ_0 = Angular displacement of cam required to produce full follower rise

The displacement-time curves plotted from the foregoing equations are shown in *Fig.* 2, while the acceleration-time curves plotted from the same equations are shown in *Fig.* 3. These curves *do not* take into account such factors as the follower-system elasticity, or the static or viscous friction which appears in any actual machine system. When these factors are taken into account, as they must be in any actual tests, an entirely different force picture appears. Typical acceleration-time charts made from the tests are shown in *Fig.* 4.

The charts in *Fig.* 4 show two important characteristics which are not apparent from the theoretical curves in *Fig.* 3. They are (1), that the forces produced by the parabolic and harmonic profiles are about twice as great as expected; and (2), the sudden application of these forces causes the follower system to vibrate at its natural frequency. The vibration takes place during both index and dwell periods.

It can be shown mathematically that the deflections of an elastic and undamped system produced by

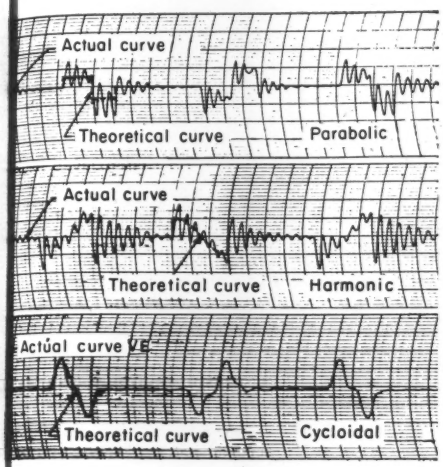


Fig. 4—Typical acceleration versus time charts at 100 rpm cam speed. Accelerations are directly proportional to forces exerted on the followers

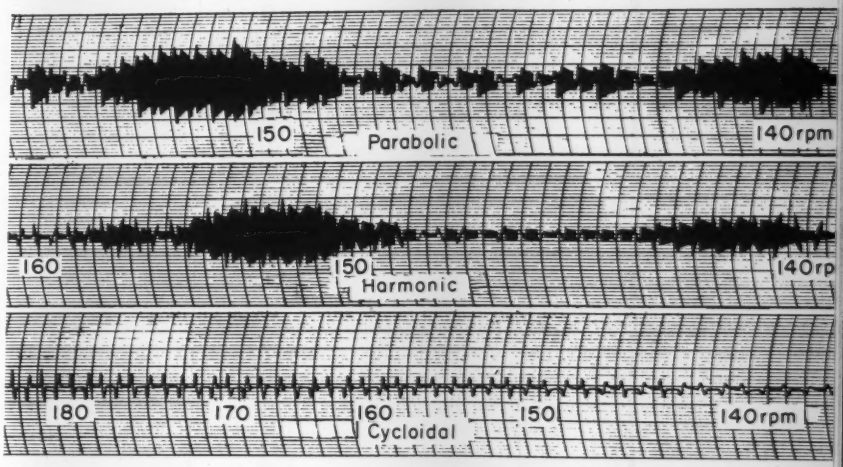


Fig. 5—Effect of resonance on stresses in the follower system

instantaneously applied forces are exactly twice as great as those produced by gradually applied forces. It follows, therefore, that the stresses produced must be twice as great. In the systems considered here, the inherent elasticity and slight damping produced the force amplification which was noted.

Resonance Severely Increases Vibrations

The theoretical acceleration curves for the parabolic and harmonic cams show clearly how the follower-system vibration is excited. The vibration is caused by the sudden force application which is a characteristic of the two profiles. Any system, acted upon by an instantaneously applied force, will vibrate at its natural frequency until and unless the vibrations are damped out. Furthermore, as the frequency of application of the impressed force approaches odd integral multiples of the natural frequency of the system in question, that system starts to resonate, and the amplitude of the vibrations increases drastically. The impressed force which causes the vibration may be one which is applied instantaneously with a definite frequency of repetition, or it may be one which varies sinusoidally with time. All that is necessary to produce resonance is that the frequency of the impressed force be in the proper ratio to the natural frequency, and that the two have the proper phase relationship.

The conditions just discussed were all noted in the tests which were made on the parabolic and harmonic cams. They appeared only to a very small degree in the cycloidal profile tests, because there is no point on the cycloidal displacement curve at which instantaneously applied accelerations occur. The acceleration changes continuously, but its rate of application is always definite and relatively small.

The conditions mentioned are illustrated in *Figs.* 4 and 5. *Fig.* 4 shows the effect of the instantaneously applied acceleration. A considerable amount of vibration is excited here and dies out in accordance with the amount of damping which is present. It is interesting to note that in the case of the parabolic and harmonic cams, a large amount of follower vibration takes place during the dwell period. This situation appears to a much smaller degree with the cycloidal cam.

Fig. 5 shows the effects of resonance on the stresses appearing in the follower system, and forces produced by the follower system. In the curves, the speed of rotation was reduced gradually and the follower system allowed to resonate at will. The parabolic and harmonic profiles both excited resonance at speeds of about 150 and 140 rpm, while the cycloidal profile showed a slight tendency to excite resonance at about 160 rpm, and again at 190 rpm, a speed which could not be attained with the other cams because of excessive machine vibration. In all the curves in *Fig.* 5 the follower natural frequency was 162.5 cps.

In the tests made, the damping in the follower system was about 5 per cent of critical. This value is low for most common cam-and-follower assemblies, in which the damping may be as much as 15 per cent of critical. If an increase is made in the damping, the damping forces will increase very rapidly, since they are proportional to velocity. At high speeds and high damping ratio, the damping forces may be expected to be much larger than the inertia forces, and the increase in damping will have no net beneficial effect. In fact, the excessively high damping forces may be a disadvantage which necessitates the redesign of some machine parts.

Follower Resonance Prevented

Fig. 6 shows charts of velocity and acceleration or force against time for the three profiles studied. During this test the only variable was the cam rotational speed, all other factors being held constant. The charts show that in general the cycloidal profile does not cause excitation of follower resonance, as do the other profiles. The cycloidal profile allows the follower to reach a dwell position without the excessive vibration caused by the other profiles. It should be noted also that the peak velocity values do not decrease with decreasing cam speed nearly as rapidly as do the peak force

values, as can be seen from a study of *Fig.* 6.

In general, the cycloidal profile produces slightly lower peak forces than do the other profiles. For an undamped system, the peak forces should be in the ratio of parabolic to harmonic to cycloidal—2.4 : 2.0:1.4; however, the peak velocities are in the ratio of 1.3 : 1.0 : 1:3, and the forces due to any damping become a greater part of the cycloidal or harmonic total force picture than of the parabolic total force. This can easily be seen by adding the values directly; then the figures become 3.7, 3.0, and 2.7, respectively, and a slight increase in the values will affect the cycloidal the most, and the parabolic the least of the three. As the general force level is raised slightly, the curves of the three types become closer together.

CONCLUSIONS: The test results show clearly that the cycloidal profile has at least two obvious advantages; they are:

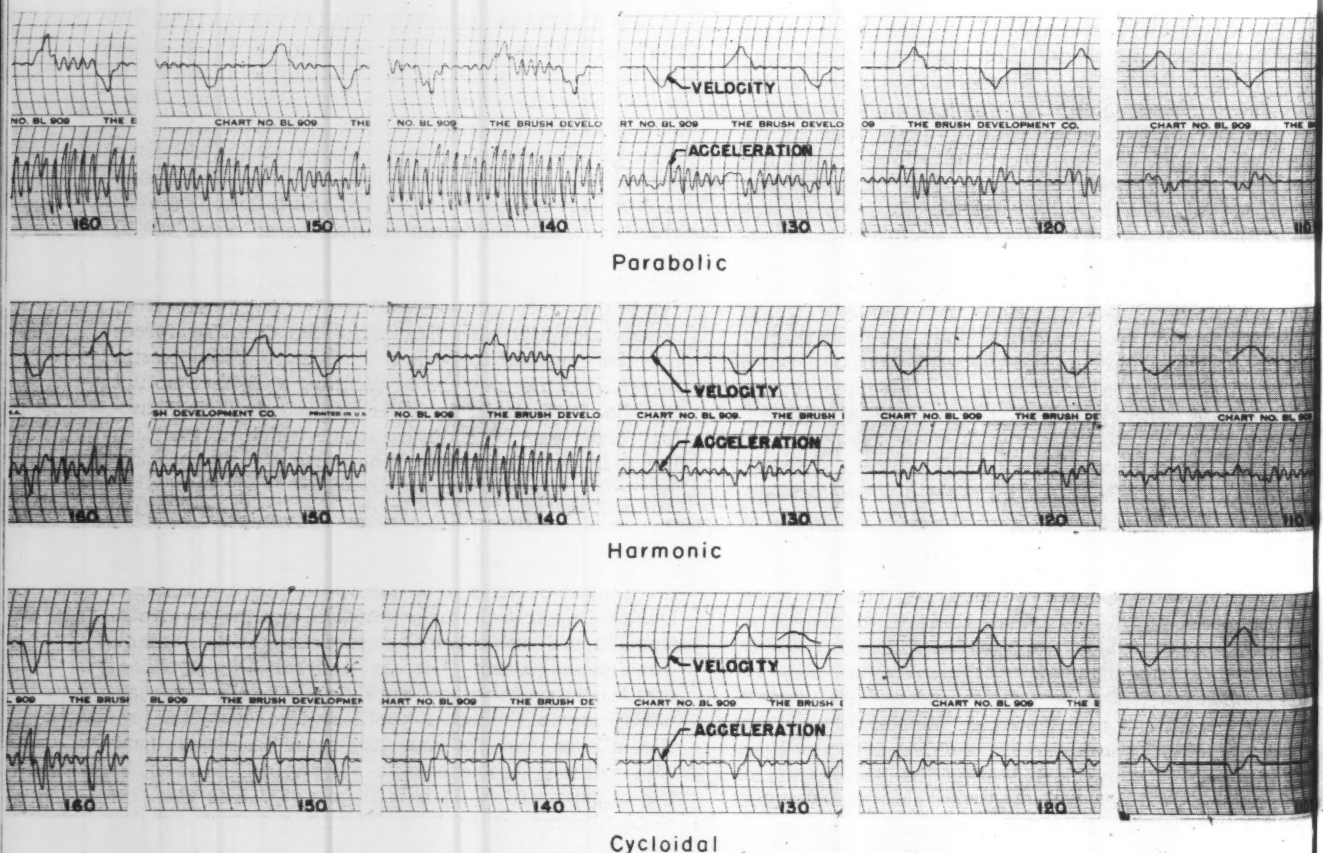
1. The *peak forces* produced are generally slightly lower than those produced by the other profiles.
2. The *oscillatory forces* produced are much smaller in amplitude than those produced by the other profiles. This should permit higher machine speeds without excessive vibration and should make both cams and followers wear longer in service.

Fig. 6—Charts showing follower velocity and acceleration versus time at fixed speeds ranging from 160 rpm down to 110 rpm. Charts for 60 to 100 rpm (not shown) show vibrations diminishing with speed

The maximum pressure angle for the cycloidal profile is greater than that for the harmonic curve, other dimensions being equal. This should mean that more power is required to drive the cycloidal cam. However, it can be seen from the curves in *Fig.* 6 that the instantaneous force velocity, or power, product at the mid-point of index will only be greater for the cycloidal when no follower oscillations are taking place in a comparable harmonic cam. The test results show that this is seldom the case. Furthermore, it is usually possible to increase the size of a cam when making a design so that the pressure angle can be reduced as desired.

A most important point in the reduction of oscillatory forces when using any type of cam profile is the construction of the follower system. This should be made as stiff as possible with as low a mass as possible. In special cases where a system having a low natural frequency must be used, damping may be introduced into the follower system itself, but never between the follower and the machine frame.

Extreme accuracy of machining is required to effect true cam profiles of any pattern. This is especially important in the case of the cycloidal cam where a definite rate of application of acceleration must be produced. Since the other profiles produce an instantaneous acceleration before and after a dwell, which is the worst possible physical condition, slight inaccuracies in machining will not be particularly harmful.



Graphical Solution of Quadratic Equations

By Carl P. Nachod
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Louisville, Ky.

DETERMINING roots of quadratic equations is often a tedious process that can be simplified by nomographic solution. Eliminating the conventional algebraic method, the chart on the following page can be used to find the real roots of any quadratic of the form

$$x^2 + bx + c = 0$$

For chart use, the equation must be set up as above so that the coefficient of x^2 equals unity.

The chart gives only positive values of x if the signs of both b and c are maintained as they appear in the equation to be solved. However, any negative roots can also be obtained from the chart by merely reversing the sign of b. Typical solution combinations are illustrated on the chart. The top center diagram applies for the first two examples given below. Examples 3 and 4 are represented by the top right diagram.

Example	Quadratic	Roots
1	$x^2 + 5x + 4 = 0$	$-1, -4$
2	$x^2 - 5x + 4 = 0$	$+1, +4$
3	$x^2 + 5x - 4 = 0$	$+0.7, -5.7$
4	$x^2 - 5x - 4 = 0$	$-0.7, +5.7$

All positive roots for these examples can be found on the chart by using b and c with their signs unchanged. For Example 1, however, both roots are negative since they can be obtained only by changing b from $+5$ to -5. For Example 3 the root, -5.7, is found by changing b from $+5$ to -5. The root, -0.7, for Example 4 is found by changing b from -5 to $+5$.

The ranges of coefficients b and c are from plus 10 to minus 10. For cases in which b or c, or both, exceed 10, a simple substitution method may be used to bring the solution within chart range. For example, the roots of

$$x^2 + 15x - 76 = 0$$

may be found by letting $x = nx_n$ and dividing by n^2 so that

$$x_n^2 + \frac{15x_n}{n} - \frac{76}{n^2} = 0$$

Letting $n = 5$,

$$x_n^2 + 3x_n - 3.04 = 0$$

From the chart,

$$x_n = +0.8, \; -3.8$$

Since $x = 5x_n$, the true roots are

$$x = +4, \; -19$$

The value of n is arbitrary. It may be any convenient number that reduces both b/n and c/n^2 to 10 or less. The same method may be used to enlarge small coefficients to practical scale quantities. For such cases, of course, n must be less than one.

Charts for quadratic equation solutions of any range can be easily constructed:

Lay off parallel b and c scales, separated by the distance k.

Mark off b and c values linearly in units common to k with the zero points located on the same level. Plot positive values upward, negative downward.

Calculate co-ordinates for locations of x values by means of the following equations:

$$h = \frac{k}{x + 1}$$

$$v = \frac{x^2}{x + 1}$$

where h is the distance from the b scale toward the c scale and v is the distance downward from the zero line of b and c.

Real and equal roots

Real and unequal roots

Real and unequal roots

Imaginary roots

How to Determine Sign of X

Sign, + or− ,of c must be maintained. For b, however, change of sign may be necessary to find one or both roots from chart.

Any root obtained with sign of b unchanged is positive. Any obtained with sign reversed is negative.

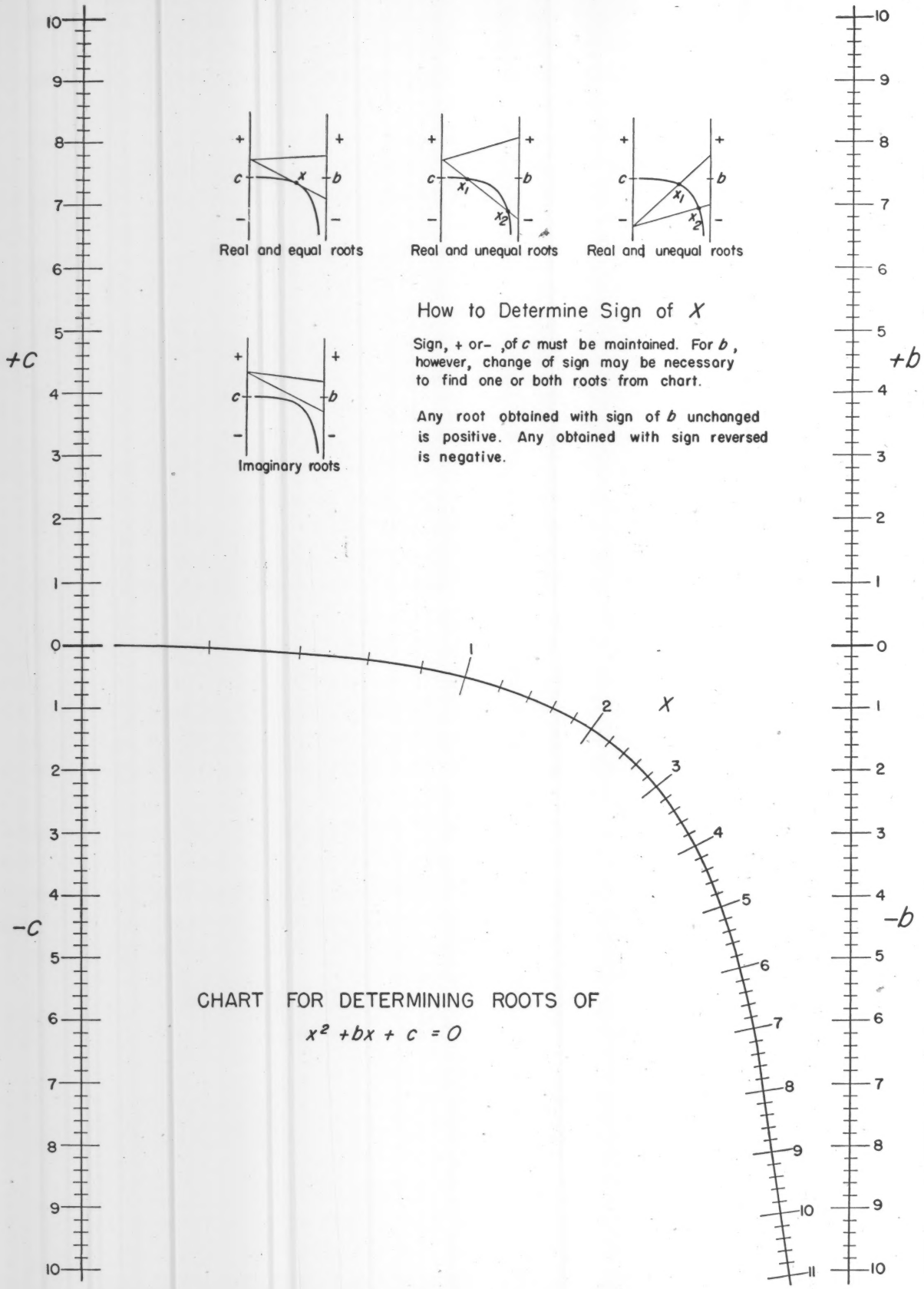


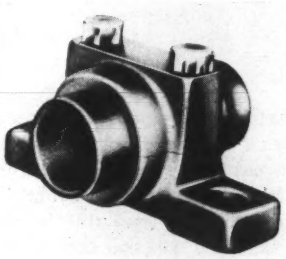
CHART FOR DETERMINING ROOTS OF

$x^2 + bx + c = 0$

NEW PARTS AND MATERIALS

For additional information on this new equipment see Page 173

Industrial Glass Bearings

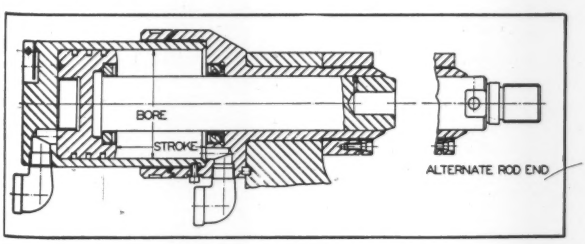


Resistant to acids, alkalies and abrasives, these industrial glass bearings have little friction loss and are custom built to operate in almost any fluid at speeds to 4500 rpm. Bearings are cast iron or low carbon steel backing with glass coating fused into the surface to form continuous covering from 0.005 to 0.015-in. thick. Synthetic rubber is employed on the shaft as a journal to protect the bearing surface against wear, shaft whip and vibration. Units will operate at temperatures above boiling point and are lubricated effectively by most fluids. Bearings are available in sizes for shaft diameters to 12 in. and will operate in horizontal or vertical position. Sleeve units are of radial, thrust or combination radial-thrust type. Manufacturer: Farley M. Caldwell, 1107 Richwood Ave., Cincinnati 26, O.

For additional information circle MD 1 on Page 173

High-Pressure Hydraulic Cylinder

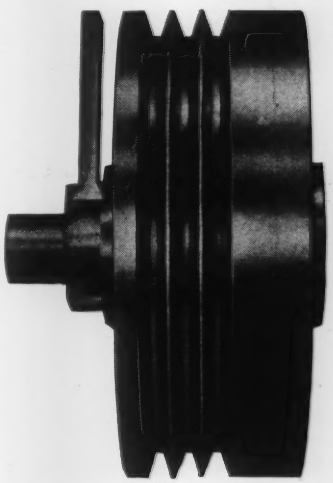
Built especially for push-stroke applications using up to 5000-psi presure, the Hy-Power standardized line of hydraulic cylinders is available in nine sizes from 2 to 7¼-in. bore. They can be used with the Hy-Power generator which supplies up to 1000-psi



pressure for approach and return strokes and then automatically multiples pressure by five for power stroke. Output force on push applications ranges from 7½ to 100 tons with 5000-psi hydraulic pressure on head end of piston. Cylinders are particularly suitable for use where space is limited and high output force is needed as in many riveting, punching and pressing operations. Manufacturer: Hannifin Corp., 1116 S. Kilbourn Ave., Chicago 24, Ill.

For additional information circle MD 2 on Page 173

Reduction Pulley



Essentially a V-belt pulley with a built-in set of planetary gears, this pulley provides reductions from 4.7:1 to 36.5:1. Combined with the possible motor to pulley reductions, a total reduction from motor to driven shaft of approximately 10:1 to 150:1 may be obtained. Larger ratios can be supplied on order. The unit can be furnished with clutch, automatic overload release, or both. It can be mounted between bearings or at shaft end; no flexible couplings or special mounting brackets are required. Entirely sealed, the pulley employs hardened steel gears and antifriction bearings. Especially adaptable where large reduction ratios are required, the pulley may be used wherever a shaft can be driven by a V-belt pulley from an electric motor, gasoline engine or other driver. Manufacturer: Hart Reduction Pulley Co., 2401 W. Clybourn St., Milwaukee 3, Wis.

For additional information circle MD 3 on Page 173

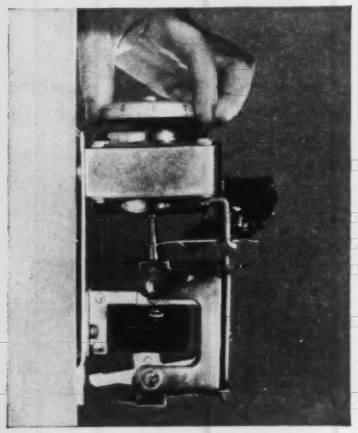
Protective Coating

Although specially suitable as a corrosion and oxidation resistant coating for metals, End-O-Rust has excellent sealing properties which adapt it for use on concrete, wood, fiber or other surfaces where more than normal protection is needed. Easily applied without special preparation of surfaces, the coating has a hard gloss finish impervious to abrasion and weathering. It will air-dry for handling in 2 to 3 hours, force-dry within 30 minutes and infrared-bake in 3 to 5 minutes. The coating is resistant to salt spray, caustic

soda, ammonia and acids as well as high or low temperatures. Manufacturer: End-O-Rust Inc., 1900 Euclid Ave., Cleveland, O.

For additional information circle MD 4 on Page 173

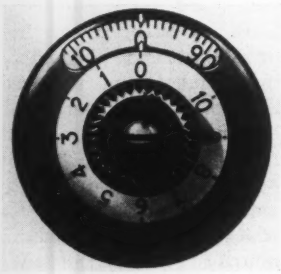
Pneumatic Time-Delay Relay



Large graduated dial of type AM pneumatic relay permits time delay adjustment from 0.2 to 200 seconds. Micro - movement-type precision snap switches with double make and break contacts are used. These switches are rated at 15 amp 115 v, continuous duty. Additional switches for interlocking purposes can be supplied. Relay is available as open or closed unit, latter in NEMA type I enclosure with conduit knockouts at top and bottom. Operating coils are available in ratings up to 600 volts ac, 25 to 60 cycles, and are designed for service down to 85 per cent of rated voltage. Manufacturer: Westinghouse Electric Corp., P.O. Box 2099, Pittsburgh 30, Pa.

For additional information circle MD 5 on Page 173

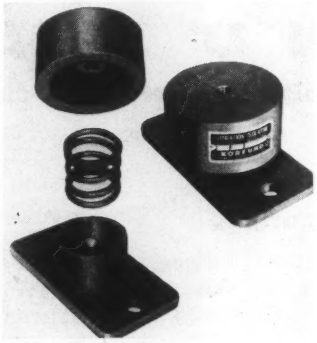
Ten-Turn Counting Dial



Applicable to any multiturn device of ten turns or less, Microdial consists of two concentrically mounted dials—one for counting increments of each turn and the other for counting turns up to ten. The incremental dial has 100 equal divisions and is attached rigidly to the shaft thereby eliminating backlash and indicating contact position to an indexed accuracy of 1 part in 1000. The turn-counting dial speeds up as the incremental dial passes from one turn to the next to remove the possibility of error in readings close to integral turns. Because there are no stops in the Microdial assembly, rotation is continuous in either direction. Requiring a panel space of only 1¾-in. diameter, the dial is delivered completely assembled and synchronized. It attaches to the shaft easily with a single setscrew. Manufacturer: Gibbs Div. of The George W. Borg Corp., Delavan, Wis.

For additional information circle MD 6 on Page 173

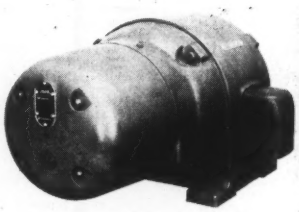
Vibration-Control Mountings



Heavy - duty construction of type F Vibro Isolator makes it especially suitable for equipment where service conditions are severe, such as in marine and mobile applications. It can be used to mount pumps, compressors, fans, engine - generator sets and similar equipment. Durable steel springs provide high isolation efficiency, and malleable cast housings are sealed by cylindrical cork ring which snubs horizontal thrust and prevents metal-to-metal contact. Vertical thrust control and sound insulation are also provided. Unit is available in several capacities for loads between 10 and 500 lb per isolator. Manufacturer: Korfund Co., 48-19-D 32nd Place, Long Island City 1, N. Y.

For additional information circle MD 7 on Page 173

Totally Enclosed Brake-Motor



Tri - Clad electric motors in sizes up to 20 hp are available with integral Stearns magnetic brakes. The explosionproof electrically - operated brake provides up to 20 hp, 90 lb-ft of torque. Brake combinations are selected to operate at 100 to 150 per cent of full-load motor torque. A single adjustment nut sets torque for specific load conditions, thus enabling operation below maximum rated torque whenever possible to conserve brake linings and lengthen brake life. Brake linings are high-friction material, and in normal operation the only maintenance required is a simple screwdriver adjustment which compensates for wear. A wear indicator, viewed through a plastic window, shows when the adjustment is necessary. All brakes are totally enclosed and because of spring-set solenoid-release design, will continue to hold even if the power fails during opeartion. Manufacturer: General Electric Co., Schenectady 5, N. Y.

For additional information circle MD 8 on Page 173

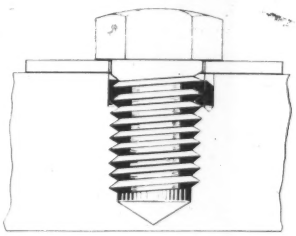
Nonjacketed Plastic Packing

Versi-pak nonjacketed plastic packing is available in two formulas: Black graphited type for general use and white nongraphited type for food handling and other special services. Dense and resilient, the material conforms readily to the shape of the stuffing

box. As the material wears, the gland can be drawn up, condensing the material and extending its service life. The packing is usable at temperatures to 350 F and at pressures to 600 psi where bull rings or close tolerance glands are provided. It can be used at higher temperatures when provision is made for cooling the stuffing box, rod and gland. Spiral and butt-cut rings are available from ⅛ to 1-in. sizes in increments of 1/16-in. Manufacturer: Raybestos Manhattan, Inc., Packing Div., Manheim, Pa.

For additional information circle MD 9 on Page 173

Spring-Steel Stud Retainer



When a stud or bolt enters Studloc, it forces this elliptical spring-steel retainer into circular shape to create rigid locking pressure on the stud threads. The stud remains in position regardless of severity of vibration. Stress load is carried by threads of the tapped hole, and the retainer floats in a counterbore so that it bears no load. The retainer can be adjusted to any position and used repeatedly without distortion. It is suitable for locking tapped adjustment screws, cylinder head studs, housing covers and flange studs and is available for bolt sizes from ⅜ to 2 in. Installation of the locking ring is accomplished by simple drilling and counterboring. Manufacturer: Security Locknut Corp., 1815 N. Long Ave., Chicago 39, Ill.

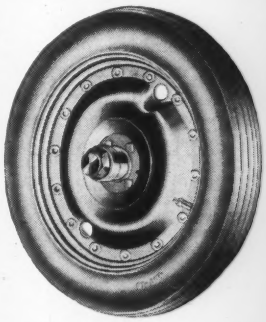
For additional information circle MD 10 on Page 173

Pneumatic Current Controller

Model EB pneumatic current controller assemblies can be used in control systems for the ultimate control of temperature, flow, speed, pH, etc., and in conjunction with a small rheostat-potentiometer for control of input to electronic speed control devices. The unit employs a standard electrical component modified for continuous throttling control service and a Cono pneumatic cylinder operator which includes an integrally mounted positioning device to provide accuracy and sensitivity of positioning to within 0.2 per cent of its total travel. Manufacturer: Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.

For additional information circle MD 11 on Page 173

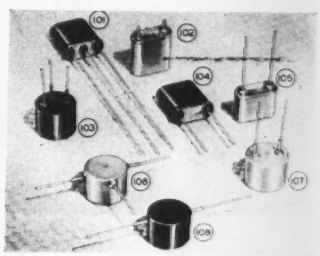
Industrial Disk Wheel



Lightweight D-140 pneumatic-tired disk wheel, 4.00 x 18, can be supplied for heavy or light-duty portable equipment. Drop-center rim double-disk wheel construction with seamless steel tubing hub is employed. Industrial tire has 27-in. diameter and is designed for good cushioning and maximum flotation. Ribbed-tread deep-groove design insures long even wear on free-rolling wheels. Load ratings vary from 835 to 1575 lb, depending on ply rating and speed. Wheels are supplied with either tapered or straight roller bearings and chain holes for theft security. Manufacturer: Geneva Metal Wheel Co., 1013 Railroad St., Geneva, O.

For additional information circle MD 12 on Page 173

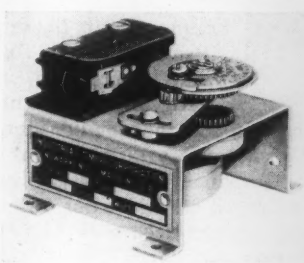
Bimetal Thermostats



Hermetically sealed in corrosion-resistant metal enclosure, these bimetal thermostats of the disk, strip and alarm types operate at temperatures from −60 to 600 F. They are designed for use in radio and electronic apparatus, electrical instruments, cameras and other precision devices subjected to dust, moisture or corrosive atmospheres. Terminals are sweat-soldered into inert metal tubes interfused with glass insulator bead enclosure. Bimetal control element eliminates artificial cycling. Thermostats are available in bright-plated or dull-black finish with conventional or special terminal arrangements. Manufacturer: Stevens Mfg. Co., 69 S. Walnut St., Mansfield, O.

For additional information circle MD 13 on Page 173

Cam Recycling Timers

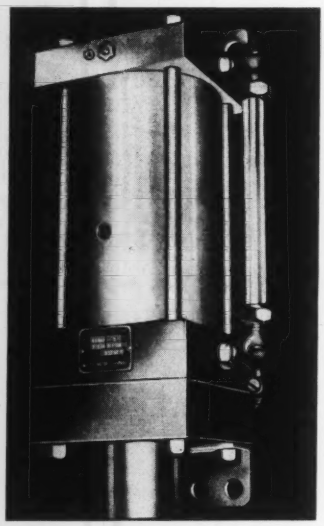


Overall time cycles can be changed on series CM cam recycling timers by substituting different-ratio gear and rack assemblies. Fifty such assemblies are available as standard equipment. More than 650 time cycles ranging from one revolution in 15 seconds to one revolu-

tion in 72 hours can be obtained from eleven different timers in series. Unit consists of heavy-duty synchronous motor, adjustable cam and single-pole double-throw snap-action switch assembled on steel chassis. The cam is adjustable for on and off cycles ranging from 2 to 98 per cent of overall time cycle. Timers have wide range of industrial control applications. Manufacturer: Industrial Timer Corp., Newark 5, N. J.

For additional information circle MD 14 on Page 173

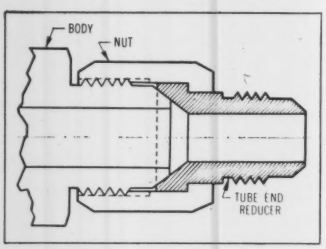
Fluid Pressure Boosters



Capable of developing pressure to 10,000 psi from ordinary plant air or hydraulic input pressure, these booster units are recommended for supplying fluid power to drive working cylinders in clamping, punching, shearing, crimping, riveting and welding operations. Operating speeds range from 30 to 450 strokes per minute. Although input pressure can be either air or hydraulic, output is always hydraulic. Models include B4 Air Miser dual pressure air or oil operated type and B2 single-acting air operated spring return booster. Manufacturer: Miller Motor Co., 4027 N. Kedzie Ave., Chicago 18, Ill.

For additional information circle MD 15 on Page 173

Tube End Reducer



Triple-lok steel fittings with a 37-degree flare can be stepped down to smaller tube sizes by this tube end reducer. Attached with a standard nut to the fitting tube end, the reducer provides a flared nose for the smaller tube size and threads for the smaller nut. The unit is made in eight sizes: $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{3}{4}$ reduced to $\frac{1}{4}$ or to $\frac{3}{8}$-in.; $\frac{3}{4}$ reduced to $\frac{1}{2}$-in.; 1 reduced to $\frac{3}{4}$-in. Brass reducers in the same sizes are also available for brass fittings used with copper tubing. Manufacturer: Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, O.

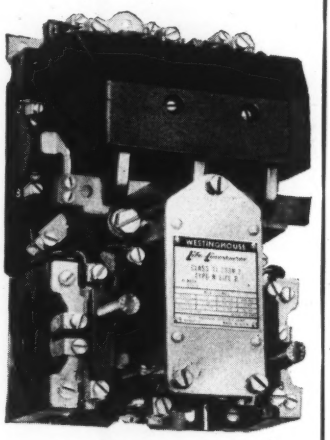
For additional information circle MD 16 on Page 173

Double-Pole Switch Timer

Operated by a spring-powered clock movement, No. 86 double-pole timer is supplied in timing ranges of 30 minutes and 1, 2 and 12 hours. Contacts are rated 15 amp at 125 v. No. 86C timer can be furnished with a relay installed for higher capacities. In operating the timer, the pointer is set for the required interval to close the switch circuit and start the timing mechanism. When the pointer reaches zero at expiration of the interval, the switch circuit is opened automatically. Whenever required, the pointer can be returned manually to zero and reset for a new interval without injuring the mechanism. The timer is available for surface or flush mounting. Manufacturer: Walser Automatic Timer Corp., Graybar Bldg., New York 17, N. Y.

For additional information circle MD 17 on Page 173

A-C Motor Starter



Magnetic, nonreversing De-ion Life-Linestarter is designed for either across-the-line starting of squirrel-cage induction motors or as a primary switch for wound-rotor induction motors. Available in NEMA sizes 0 through 4, the starters can be applied to all integral horsepower motors to 100 hp. It is supplied in standard alternating current ratings from 110 to 600 v at frequencies of 60, 50 and 25 cycles for three-phase, two-phase four-wire, and single-phase operation. Up to four electrical interlocks are obtainable for any combination of normally open or normally closed operation.

By virtue of the De-ion operating principle, arcs are extinguished in a half-cycle or less. Insulating parts of cold-molded inorganic material will not carbonize and are shock-resistant. Heavy-gage sheet steel en-

Conformability

THE tolerance of adjustment to loading or misalignment is known as conformability. If a bearing could be kept in perfect alignment with the shaft it supports and if an oil film could be maintained at all times, there would be no need for more than one bearing material. This ideal bearing material would be hard so that it would resist changes in load that would be expected in normal machine operations, whether these be starting loads, firing loads or loads due to work of the machine.

Actually it is well known that perfect alignment is seldom attained. Tolerances alone, if they are all in an unfavorable direction, can add up to slight misalignment. The tolerance in location of a hole, plus the tolerance of the bore, plus the tolerance of the bearing wall, plus the tolerance of the shaft, presents a difficult problem for the design engineer.

Part of the problem is solved by selection of a proper bearing material. Advantage is taken of a different kind of tolerance—a tolerance of the bearing material to move and adjust itself to unfavorable loading or to slight misalignment.

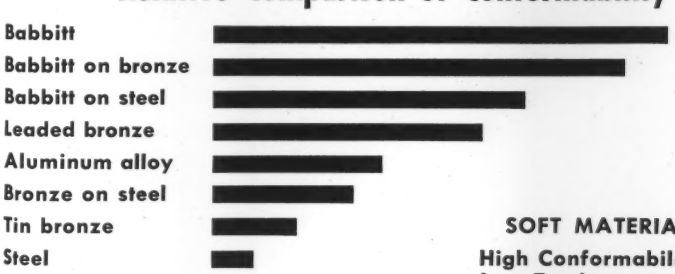
Conformability is also very important if the oil film is broken and perfect lubrication is lost for a short period. As soon as the oil film is broken the local bearing area starts to heat and local dimensions change. If the material is conformable it will move to better support the load. Then when the oil film is reestablished the bearing will run cooler than before. These are some of the changes that take place during break-in and explain why a bearing will change and even show signs of distress in the first few hours of running and yet run many hundreds and even thousands of hours with little change after break-in.

In general, soft materials conform so that conformability is an inverse function of hardness and is thus best in the babbitts. Unfortunately if a material is too soft, it will move under high loads and the properties of conformability must come to a compromise with the properties of load carrying capacity and fatigue resistance which are associated more with hard materials than soft materials. A compromise for this situation is to use a thin layer of a soft babbitt on a harder backing such as bronze or steel. Then the harder backing will carry the load while the thin babbitt will furnish desirable bearing properties and yet carry higher loads due to its thinness.

For higher loads bronze on steel is used. Conformability is sacrificed at the expense of gain in load carrying capacity with the necessity of design for more ideal conditions for bearing operation.

In the use of steel backed bearings, conformability is lost because the steel has less ability to conform compared to the bearing materials used at the running surface. If the lining material is soft it will conform, but if it must be thin conformability is limited.

Relative Comparison of Conformability



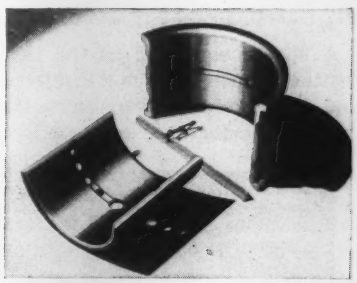
Relative properties of bearings based on wide bearing experience showing relative conformability and tolerance to scoring at expense of low fatigue resistance and low load carrying capacity. The relative position of a bearing material will change from this generalization with the composition of the alloy, for instance the amount of lead in a leaded bronze. It will also change remarkably with the thickness of babbitt on a backing material.

SOFT MATERIALS

High Conformability
Low Tendency to Score
Low Load
Low Fatigue Life

HARD MATERIALS

Low Conformability
High Tendency to Score
High Load
High Fatigue Life



Babbitt lined bronze is an ideal combination for both load carrying capacity and conformability.

If a bearing such as solid bronze is subject to a deforming load, the bronze will move, not only at the bearing surface but at the back. The whole bearing will move. The surface will conform to the new shaft position, the back will seat itself more properly and the bearing as a whole will assume a proper running position.

A bearing cannot be selected on the basis of one desirable property. If very high loads are required fatigue resistance and load carrying capacity take precedent. If corrosive conditions are encountered the selection of alloys is limited. The proper bearing material must be selected to best fit the operating conditions.

Engineering Service

Johnson Bronze offers manufacturers of all types of equipment a complete engineering and metallurgical service. We can help you determine the exact type of bearing that will give you the greatest amount of service for the longest period of time. We can show you how to design your bearings so that they can be produced in the most economical manner. As we manufacture all types of Sleeve Bearings, we base all of our recommendations on facts free from prejudice. Why not take full advantage of this free service?

•

This bearing sheet data is but one of a series. You can get the complete set by writing to—

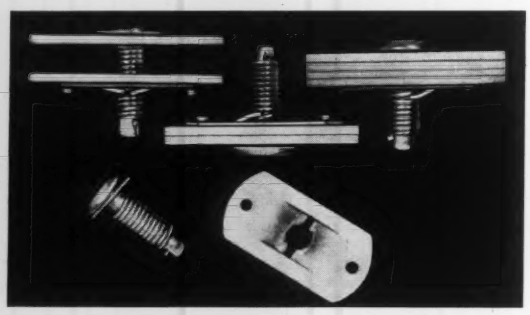
Johnson Bronze
SLEEVE BEARING HEADQUARTERS
525 S. MILL ST. • NEW CASTLE, PENNA.

closure is Bonderized and coated with a smooth baked-on gray enamel. Manufacturer: Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

For additional information circle MD 18 on Page 173

Vibrationproof Fasteners

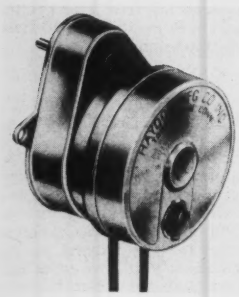
A spring employed as the threaded section of the Southco Spring-Grip fastener acts as a shock absorber and effectively cushions vibration and panel movement. The fastener will not loosen under severe vi-



bration or movement. Manufacturer: South Chester Corp., 1403 Finance Bldg., S. Penn Sq., Philadelphia 2, Pa.

For additional information circle MD 19 on Page 173

Slow-Speed Timing Motor



Available in standard speeds of 6, 8, and 12 hours, 1 day and 1 week per revolution, series 4400 timing motor is smaller and lower in cost than previous slow speed type. Through changes in gear cup and gear train design, overall depth of unit is reduced to 1⅜ in. Lubrication is simplified, and motor is interchangeable in mounting and other dimensions with faster speed units.

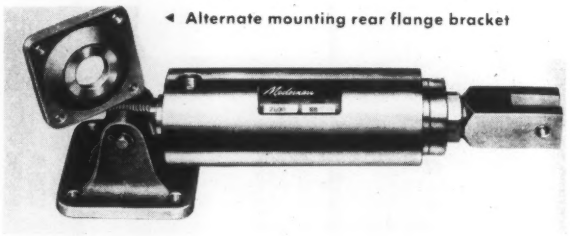
Typical applications include daily program timers and refrigerator defrosting mechanisms. Nonstandard speeds can be furnished on quantity orders in ranges of 5 to 36 hours and 2 to 30 days per revolution. Manufacturer: Haydon Mfg. Co., Torrington, Conn.

For additional information circle MD 20 on Page 173

Double-Acting Air Cylinder

Regulated by a three-way valve, this air return cylinder allows throttling to provide for control of work and of return stroke. There is no residual pressure on the forward stroke, and the return stroke is made at 60 per cent efficiency. After being initially

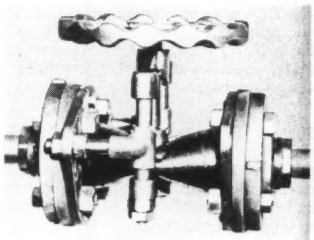
◄ Alternate mounting rear flange bracket



charged with air, the cylinder operates on the same amount of air as a spring return cylinder. Lightweight construction includes hard-drawn relief-annealed brass tubing, stainless steel piston rod, aluminum head and O-ring packing. The cylinder is available in 1⅛, 1¾ and 2½-in. bore sizes. It can be piston-rod keyed to prevent rotation for light punch and die work. Manufacturer: Modernair Corp., 4222 Hollis St., Oakland 8, Calif.

For additional information circle MD 21 on Page 173

Rubber Pinch Valve



With sufficient flexibility to offset misalignment in pipe lines, this rubber pinch valve has better wear properties, it is claimed, than similar metal constructions in applications where corrosive or abrasive materials are carried. Requiring no packing, the valve absorbs vibration, eliminates water hammer and provides a positive seal in the closed position. Its metal parts can be refitted to new valve bodies when necessary. Valve is available in neoprene for oil resistance, butyl rubber for high heat and severe acid conditions, and pure gum stock for food and beverage conveyance. Sizes range from 1½ to 12 in. Manufacturer: United States Rubber Co., Rockefeller Center, New York 20, N. Y.

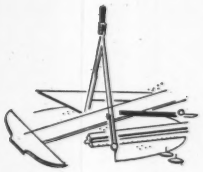
For additional information circle MD 22 on Page 173

Chemically Inert Packing

Formed entirely of Teflon, Chemiseal No. 810C packing is usable in stuffing boxes on applications which demand free spindle operation and complete resistance to chemical attack. Composed of a series of cone-shaped rings, the packing withstands temperatures from −150 to 550 F. Sealing action is derived partly from flexing of cones and does not depend entirely on deformation of packing. Supplied in sets to meet specified requirements, the packing is available with adapters for either square or chamfered-end stuffing boxes. If necessary, rings can be split for installation.

Also available from stock are Teflon sheets and

How to Cut Maintenance Costs ON YOUR MACHINES!



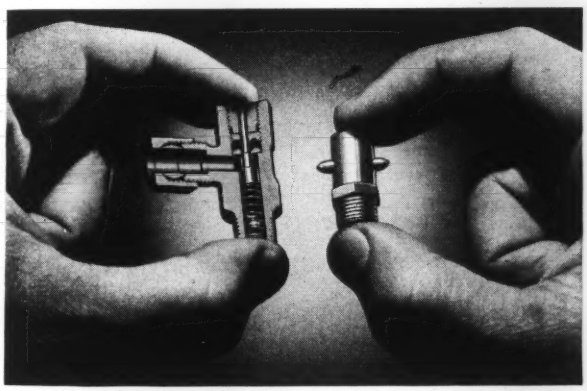
● Even the best machine design is bound to become a costly headache—unless it gets the exact lubrication it requires. Now you can assure your machines the correct *automatic* lubrication you know they require—*in advance*—with an Alemite Centralized Lubrication System.

Maintenance costs, repairs and "downtime" for lubrication can be designed right out of any machine—big or small, simple or complex. And at the same time, Centralized Lubrication can assure more production time at a lower cost per hour from every machine you design.

Since no one system suits every machine, Alemite has developed, tested *and factory-proved* 3 different automatic systems of Centralized Lubrication. Now available with manual or time-clock control, these completely enclosed, hydraulic pressure Systems eliminate the human element of error. From one safe, centralized point, your machines can receive dependable, positive lubrication keyed to their specific requirements.

Free catalogues on any Alemite Centralized Lubrication System are available upon request. If you prefer, an Alemite representative will conduct an informative, desk-top demonstration of these systems with actual models, at your convenience. Write to Alemite, Dept. R-60, 1850 Diversey Parkway, Chicago 14, Illinois.

Alemite Offers These 3 Factory-Proved Answers...



1 Alemite "Midget" System—slightly larger than a pin-type fitting, this Alemite "Midget" measuring valve is readily applicable to all types of heavy, light and precision machinery. Its simple, compact design makes it especially suitable wherever space limitations are encountered. Mounted on or near the bearings, the Alemite "Midget" delivers a measured amount of oil or grease from one central point. Can be installed for either manual or automatic operation.

ALEMITE
REG. U.S. PAT. OFF.

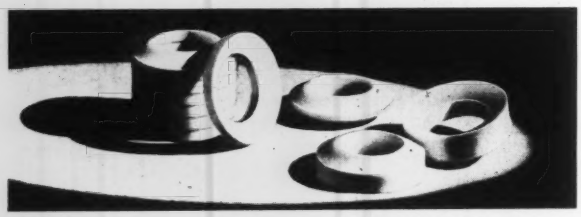
Modern Lubrication Methods That Cut Production Costs

Another Product of STEWART WARNER

2 Alemite Single Line Terminating System...applicable to heavy or light machines, precision machines, outdoor installations. It is a single lubricant line, hydraulically operated system for oil or grease. Valves can be installed on or near each bearing. A measured amount of lubricant, large or small, is conveyed to each bearing from one central point while machine operates. An indicator signals when job is done. Choice of manual or automatic operation.

3 Alemite Single Line, Reversing System is ideal where excessive dirt and moisture is a problem. The system is completely enclosed, fully hydraulic. Each valve delivers a metered amount of oil or grease to two bearings. The lubricant flows *progressively* to each bearing while the machine is producing . . . an indicator at the point of introduction signals when lubrication is completed. Designed for manual or automatic operation.

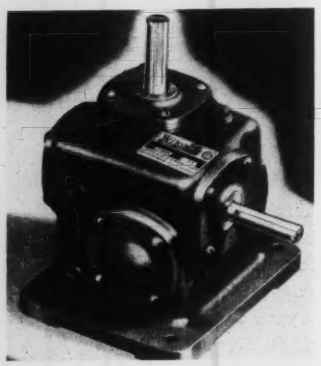
NEW PARTS AND MATERIALS



strips, blocks, rods, tubes, bars and cylinders in molded or extruded form. A variety of sizes and thicknesses can be obtained. Manufacturer: United States Gasket Co., P. O. Box 93, Camden, N. J.

For additional information circle MD 23 on Page 173

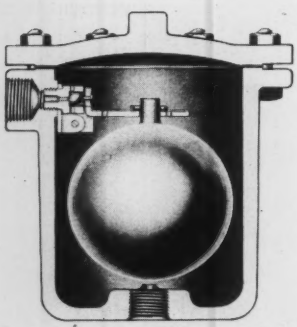
Small Speed Reducer



Type DBRA double-reduction speed reducer can be used for operating many devices such as small centrifugal fans, fuel stokers, etc. Totally enclosed in a single-piece housing, the speed reducer offers a power range of 1/20 to ⅛-hp and reduction ratios of 25:1 to 1764:1. The unit can be obtained in 24 right-angle drive assemblies. Manufacturer: Winfield H. Smith Corp., Springville, Erie Co., N. Y.

For additional information circle MD 24 on Page 173

Vent and Drain Valve

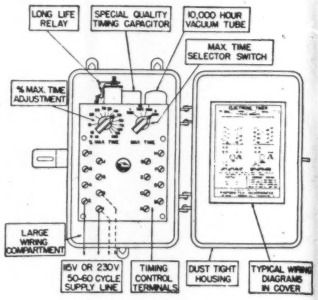


By using a simplified ball-type seating mechanism instead of the customary disk, this automatic vent and drain valve insures more accurate seating and longer life. Valve is easily installed in water or oil piping systems to remove entrapped air, or in compressed air systems to remove water and oil. Operation is fully automatic—the cycle of filling and emptying repeats with each accumulation.

A complete range of sizes is available for air requirements up to 150 psi, and water to 125 psi. Body and cap of valve are cast iron and float is copper. Ball seat is Exelloy and ball is hardened stainless steel. Manufacturer: Crane Co., 836 S. Michigan Ave., Chicago, Ill.

For additional information circle MD 25 on Page 173

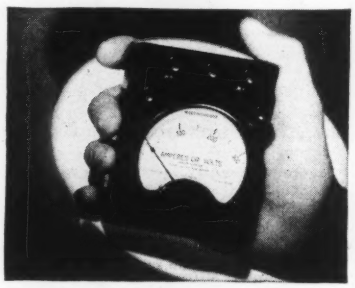
Electronic Timer


LONG LIFE RELAY
SPECIAL QUALITY TIMING CAPACITOR
10,000 HOUR VACUUM TUBE
MAX. TIME SELECTOR SWITCH
% MAX. TIME ADJUSTMENT
LARGE WIRING COMPARTMENT
115V OR 230V 50-60 CYCLE SUPPLY LINE
TIMING CONTROL TERMINALS
DUST TIGHT HOUSING
TYPICAL WIRING DIAGRAMS IN COVER

Interval, delayed action, automatic repeat and programming types of timing as well as variations of these are provided by series 30 electronic timer. This flexibility is accomplished by bringing out many points of the circuit through terminals on the front panel. Circuit is self-compensating for changes in line voltages. Replacement of the vacuum tube will not alter original 2 per cent limit of accuracy variation. Employing only one tube and one relay, the unit operates on 115 or 230 v 50/60 cycles and consumes 25 w; relay contact rating is 10 amp 115 v ac noninductive. Output is through two single-pole double-throw switches. Manufacturer: Photoswitch Inc., 77 Broadway, Cambridge 42, Mass.

For additional information circle MD 26 on Page 173

Portable Instruments

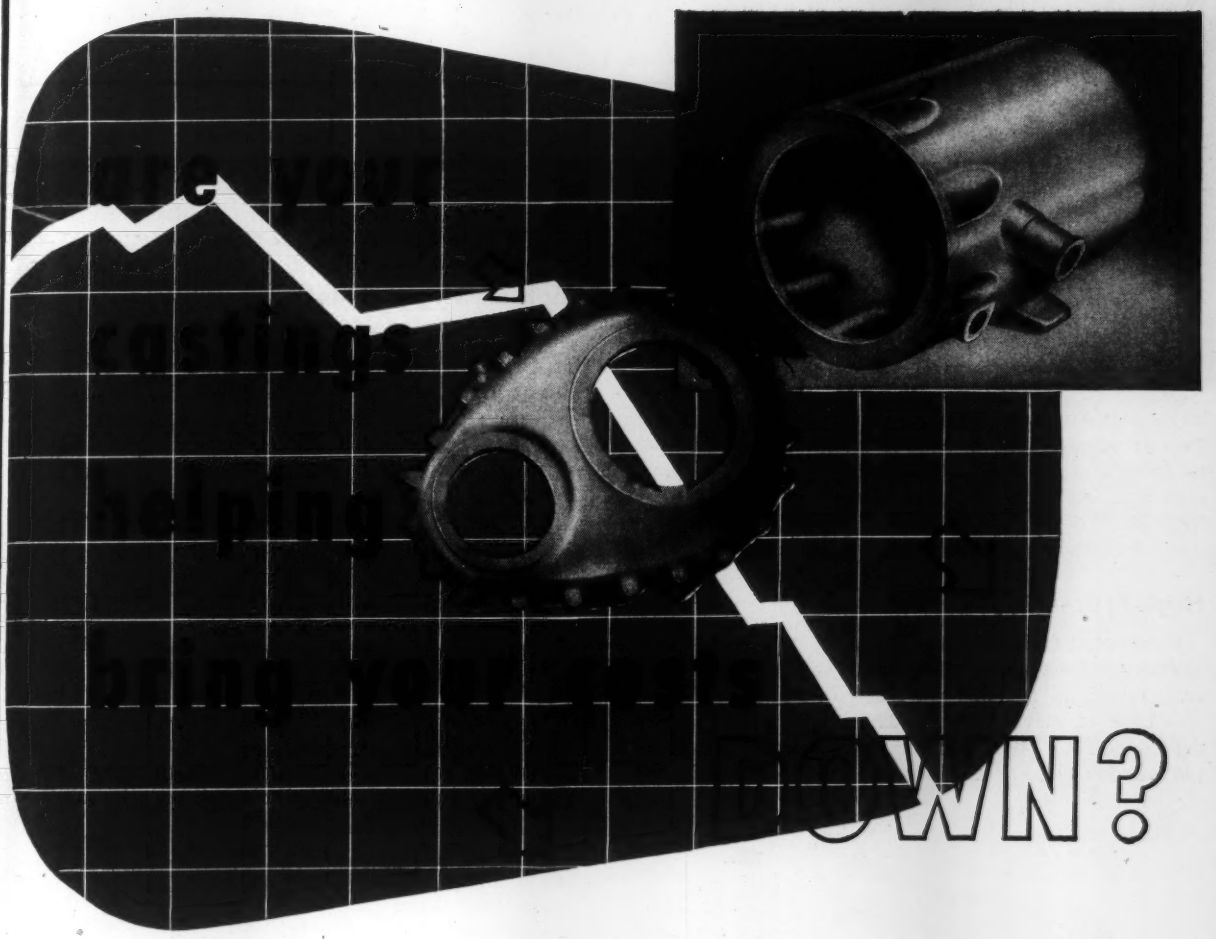


Including single and multiple range models, P-12 line of portable instruments utilizes both moving - iron and permanent - magnet moving - coil mechanisms in a compact molded case. Ammeters are available in full-scale ranges from 20 microamperes to 50 amp dc and from 5 ma to 50 amp ac. For direct-current voltages, full-scale ranges run from 10 mv to 800 v, with alternating current ranges from 1.5v to 300 v. Rectifier milliammeters are obtainable in full-scale ranges from 0.5 to 10 ma and rectifier voltmeters from 2 to 800 v. The instruments are magnetically shielded to permit use on both magnetic and nonmagnetic surfaces and with as close a spacing as required. Manufacturer: Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

For additional information circle MD 27 on Page 173

Selenium Rectifiers

A vacuum vaporization process is employed to produce these metallic selenium rectifiers of heavy-duty quality in large-plate sizes. Selenium is deposited uniformly over the entire plate area without flaw spots. Units have low resistance in conducting direction and can withstand high inverse voltage. Standard size plates measure from 1 x 1 in. to 6 x 12 in., and special



A SURVEY of your aluminum castings requirements by Permite engineers may bring you important economies.

Structural design recommendations, made by Permite aluminum casting specialists, often increase the originally planned strength and bring savings in metal and machining, without affecting the utility of the part.

Also available to you, is Permite metallurgical cooperation in selecting the best alloy to provide all the desired qualities in the casting at the *lowest ultimate cost*.

The vast Permite foundries provide today's most advanced facilities for producing aluminum castings by the permanent mold, semi-permanent mold, sand or die casting processes. Complete laboratory control and strict inspection procedures guard the quality of your castings from start to finish.

Permite service and castings are helping many manufacturers bring costs down. Submit blue prints for recommendations and estimates on your castings requirements.

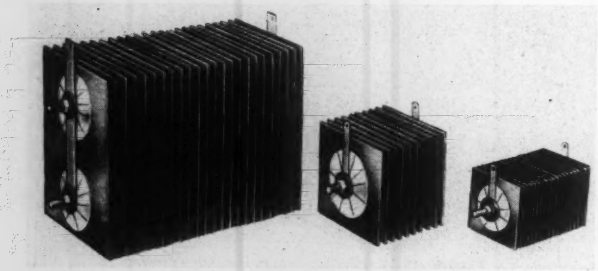
PERMITE

ALUMINUM INDUSTRIES, INC.

CINCINNATI 25, OHIO

ALUMINUM PERMANENT MOLD, SAND and DIE CASTINGS...HARDENED, GROUND and FORGED STEEL PARTS

NEW PARTS AND MATERIALS

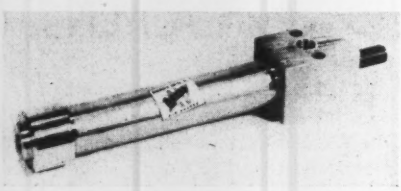


large plates can be made to order up to 12 x 52-in. Two or more studs are used in stacking larger plates to provide stiffness and mechanical strength. Manufacturer: Syntron Co., 260 Lexington Ave., Homer City, Pa.

For additional information circle MD 28 on Page 173

High-Pressure Cylinder Valve

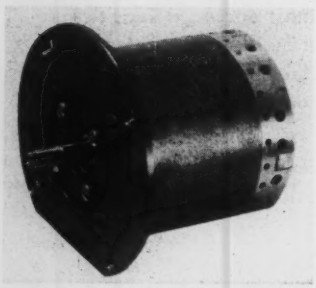
Fabricated from solid brass bar stock, model 0-1000 cylinder valve for air, oil or water service has a pressure range up to 1500 psi and can be energized by any type of valve control. The standard cylinder is drilled and counterbored for mounting either on the piston rod end or on the side or foot. It is furnished as



double-acting, but a single-acting model with internal springs or other special types are available according to specification. The unit employs self-adjusting packing and can be furnished with length of stroke to suit requirement. Manufacturer: Airmatic Valve Inc., 1643 E. 40th St., Cleveland, O.

For additional information circle MD 29 on Page 173

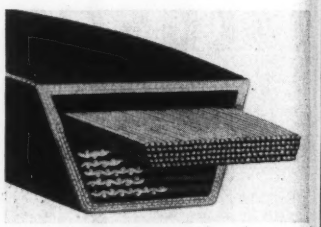
Magnetic Clutch



Designed for servos and other mechanisms where rapid engagement and release are required, this magnetic clutch delivers a maximum torque of 4 lb-in. at speeds up to 3600 rpm. Capacity is 0.20-hp with 3-w dc input. When the electromagnet is energized, the cork-faced driven disk is clamped between two driving members. For high-torque transmission, the driven disk is faced on both sides. A splined bore in the driven disk permits easy coupling to the load. The electromagnet—imput 3w dc or rectified ac—is nonrotating with flange mounting. Driving plates are ventilated for rapid cooling. Manufacturer: Barber-Colman Co., Rockford, Ill.

For additional information circle MD 30 on Page 173

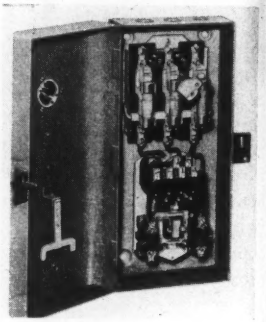
High-Strength V-Belt



Incorporating chemically produced fiber of high strength, low stretch and good shock-absorbing qualities, Hy-T V-belt is water and mildew resistant. Inherent resistance to shrinking gives the belt length stability and allows handling of heavy torque loads. Manufacturer: Goodyear Tire & Rubber Co., Akron, O.

For additional information circle MD 31 on Page 173

A-C Magnetic Starters



Available in fusible and nonfusible types, Bulletin 4120 alternating current magnetic starters combine disconnecting means, motor running over-current protection and starter. Fusible type also affords motor branch circuit over-current protection. Components are arranged in NEMA type 1 general-purpose enclosures. Front-operated units provide manually-reset thermal overload protection, high arc interruption capacity, provision for padlocking in 'on' and 'off' positions and interlock protection in 'on' position.

Four standard sizes up to 50 hp, three phase, 550-v, 60-cycle maximum are obtainable. Standard operating coils can be supplied for 110, 220, 440 and 550-v service on frequencies of 25, 50 or 60 cycles. On special order, automatic reset overloads, local control 'start-stop' pushbuttons or 'hand-off-automatic' selector switches can be furnished. Manufacturer: Ward Leonard Electric Co., Mount Vernon, N. Y.

For additional information circle MD 32 on Page 173

Electrolytic Capacitor

Indicated advantages of this 1-mfd 150-v dc Tantalytic capacitor are longer shelf life, greater stability, lower leakage currents, and better low-temperature characteristics than conventional capacitors. These properties are attributed to the use of tantalum in foil with a newly developed noncorrosive electrolyte. This construction has also resulted in a size reduction

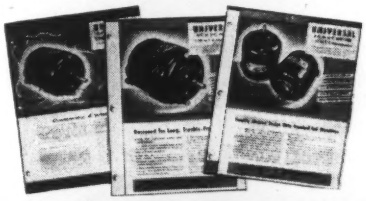
YOU'LL LIKE THESE NEW R & M UNIVERSAL MOTORS

They Help You Solve Your Problems!

High starting torque; high operating speed; adaptability to speed control—to *these* inherent characteristics of series motors Robbins & Myers has added *many performance advantages.* New, completely redesigned R & M universal motors, from 1/100 to 1/3 horsepower, are ready *now* for powering your small equipment.

BETTER, INSIDE AND OUT

From their *dynamically balanced* armatures to their rigid, welded-steel shells, nothing has been slighted. Commutation, brushes, bearings, insulation, and ventilation all represent *true progress*—progress backed by the competence born of long, successful experience.

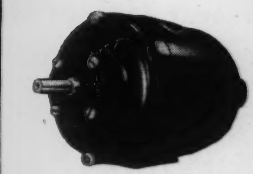


STANDARD TYPES—AND "SPECIALS," TOO

In the four frame sizes, there's the *right motor* for every need—sleeve or ball-bearing; fixed rotation or reversible; open or totally enclosed; standard or special ratings . . . and a *welcome variety* of housing types and end-heads.

YOURS FOR THE ASKING

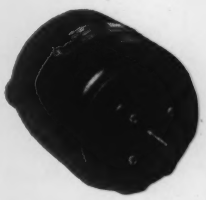
We'll be glad to send you literature on these new motors. And, if you would like to have R & M sit in on a discussion of *powering improvements*—that's yours for the asking, too. Address Robbins & Myers, Inc., Motor Div., Dept. E-60, Springfield 99, Ohio.



STANDARD PAD BASE

STANDARD LOW BASE
(Also "Medium" and "High" Types)

HUB MOUNTING



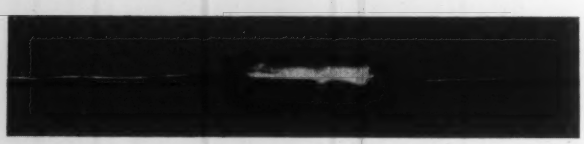
FACE MOUNTING

FLANGE MOUNTING

FOR MODERN, COMPACT PRODUCT STYLING—USE

MOTORS by ROBBINS & MYERS

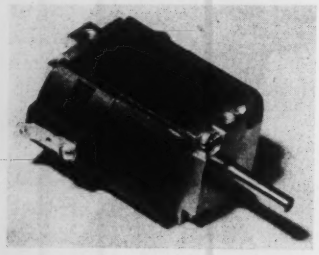
NEW PARTS AND MATERIALS



up to 90 per cent that required by paper capacitors. Manufacturer: General Electric Co., Schenectady 5, N. Y.

For additional information circle MD 33 on Page 173

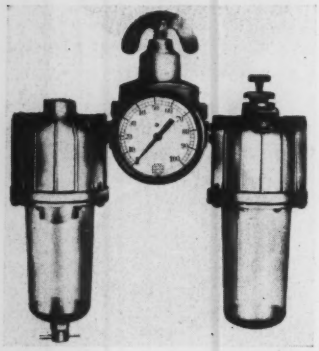
Permanent Magnet Motor



Developing 1/120-hp and 1.4 oz-in. torque at 6000 rpm, this permanent magnet direct-current unit can be supplied as a motor or generator with voltages from 3 to 110 dc. Current consumption is 0.5-amp at 12-w input. Reversible rotation can be obtained by changing the polarity or armature leads. The motor can be furnished with enclosed worm gear or open spur gear reduction. It is designed for continuous service. Manufacturer: Electro Engineering Products Co., 4824-28 W. Kinzie St., Chicago 44, Ill.

For additional information circle MD 34 on Page 173

Air Line Control Unit



Combining the Goodyer Pur-o-fier and Pur-o-luber with a common regulator and gage, this Airlube control unit purifies and lubricates low-pressure air. The Pur-o-fier precipitates water and oil by a scrubbing action and cleans with a series of impinging baffles arranged for maximum surface contact. A transparent plastic bowl permits a visible check on dirt entrainment level and carries a petcock for easy drainage. The unit has a 45-cfm capacity and withstands pressures up to 250 psi.

Pur-o-luber regulates the delivery of suspended oil vapor in accordance with changes in air pressure. This unit operates under a maximum pressure of 125 psi and has a ½-pt capacity reservoir. Both the Goodyer Pur-o-fier and Pur-o-luber can be supplied for operation as separate units. Manufacturer: Airlube Inc., 3422 W. North Ave., Chicago 4, Ill.

For additional information circle MD 35 on Page 173

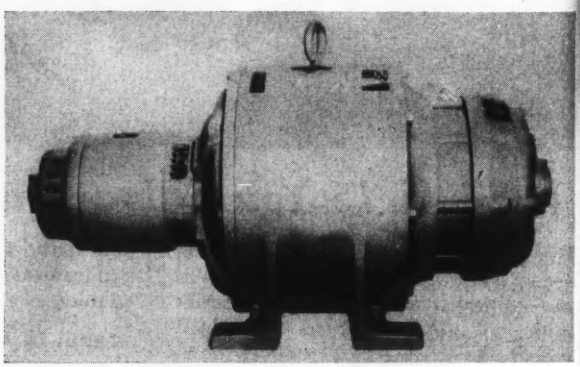
Low-Tension Electrical Conductor

Type PE-400 low-tension cable is the insulated single-conductor 1000-v type. The conductor is silver-plated stranded copper, and insulation consists of glass-reinforced Teflon laminated tapes with enamel finish. Insulation withstands high heat and is inert to all known solvents. It is also fungi-resistant and withstands abrasion well. Cable conforms to Bureau of Aeronautics Specification XEL which calls for 400 F heat resistance. It is supplied in gage sizes from No. 20 to No. 8. Manufacturer: General Motors Corp., Packard Electric Div., Warren, O.

For additional information circle MD 36 on Page 173

Motor-Generator Set

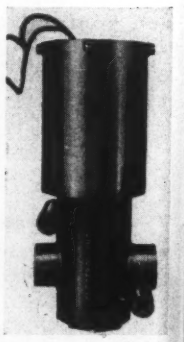
Compact, this separately-excited high-frequency motor-generator set delivers 2-kva 3510-cycle three-phase power. The unit employs a 5-hp 220/440-v three-phase 60-cycle ac motor to drive a directly



mounted 48-v dc generator which excites a 100-v inductor alternator to deliver power. The unit is dynamically balanced and permanently lubricated. Manufacturer: Electrical Specialty Co., Stamford, Conn.

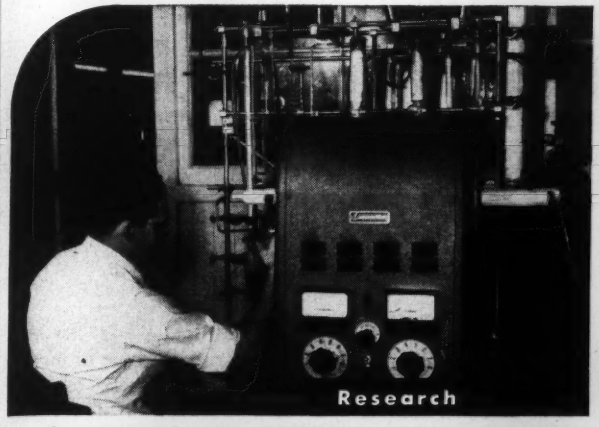
For additional information circle MD 37 on Page 173

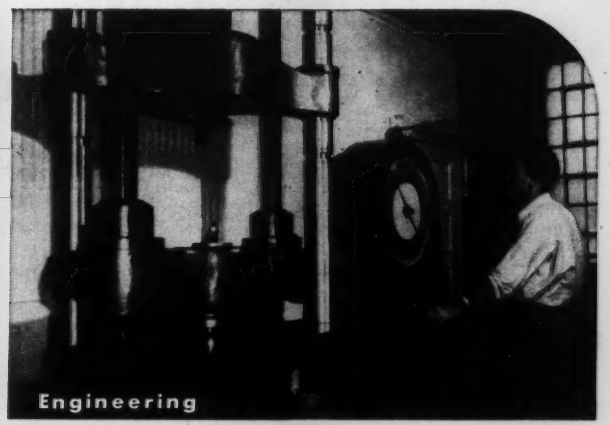
Poppet-Type Solenoid Valve

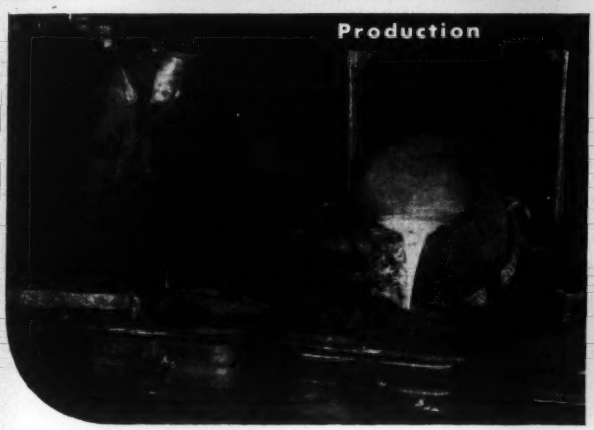


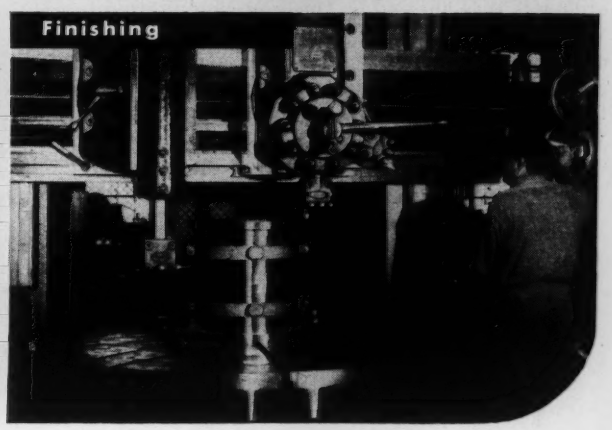
Available as normally open or normally closed, this two-way direct-current poppet-type solenoid valve can be used with oil, air or water at pressures up to 1500 psi. The solenoid is designed to withstand constant energizing and is obtainable in voltage increments ranging from 6 to 220-volts dc. The valve has two ½-in. NPT ports, with maximum rated flow of 5½ gpm. Standard hydraulic packings are employed to minimize internal leakage. Reducing bushings are supplied where other size ports are required. Manufacturer: Electrol Inc., Kingston, N. Y.

For additional information circle MD 38 on Page 173









WHICH

N.B.M. service is most important

FOR PRODUCING BETTER BRONZE BEARINGS AND CASTINGS?

The answer is that *ALL FOUR* are equally important... and ALL FOUR represent the reasons why more and more users of Non-Ferrous Bearings and Castings become N-B-M Customers.

The complete facilities of National Bearing Division for Research, Engineering, Production and Finishing are unique. They represent an important *chain of service*—an ability to translate your *problems* into *requirements*, and requirements into *actual products* that serve you better.

The most modern equipment for alloy testing, molding, casting and finishing assures you of finer, more dense, closer-to-size bearings and castings—products that have higher resistance to wear and greater long-range economy.

Yes, this complete N-B-M Service is worthwhile investigating. Call in your nearest N-B-M Representative—he will gladly show you how this service can be geared to serve you with maximum efficiency.

THIS NEW CATALOG completely describes N-B-M Facilities—how they can cut costs for you and tie in with your own production. Write for a free copy today.

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION

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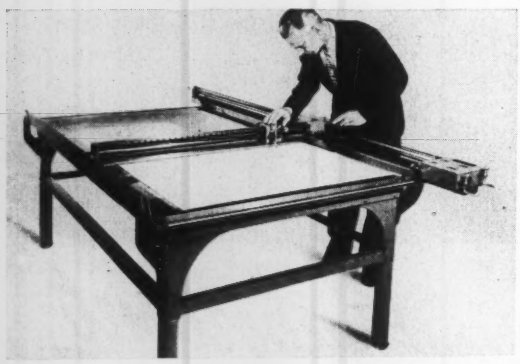
PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

ENGINEERING DEPARTMENT
EQUIPMENT

For additional information on these new developments see Page 173

Precision Plotting Table

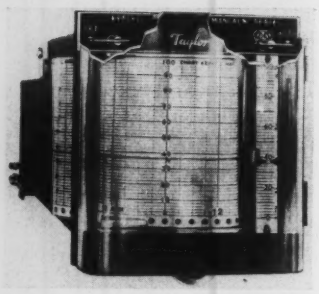
Accurate and rapid layout, plotting or measuring of points on a plane surface in terms of rectangular co-ordinates is facilitated by this precision plotting table. Values of co-ordinates are registered on mechanical counters to nearest 0.001-in. Carriages for X and Y axes are positioned quickly to the nearest inch, and two hand cranks provide means for intermediate adjustments within 0.001-in. Standard units have a 4 x



6-ft working surface and are based on decimal inch measurements; other sizes and metric divisions can be supplied. Manufacturer: Fairchild Camera & Instrument Corp., 53 W. Union St., Pasadena 1, Calif.

For additional information circle MD 39 on Page 173

Strip-Chart Process Recorder



Transmitter output is received and recorded by the Transet recorder in terms of the process variable measured. The instrument is suitable for pneumatic transmission of flow, liquid level, pressure, and temperature. A chart, three inches wide, travels one inch per hour from right to left to produce a process record. The chart may be torn from the left side as needed. Electrically driven chart mechanism is designed to pull out like a camera. The scale at the right shows the actual process range of the transmitter and additionally is graduated from 3 to 15 psi for noting valve position and checking calibration. Adjustments can be made for instant checking of valve position and for automatic or manual service. Micrometer screws provide zero adjustment for pen and set-pointer. Four forms of the receiver are available. Manufacturer: Taylor Instrument Cos., Rochester 1, N. Y.

For additional information circle MD 40 on Page 173

Diazo-Sensitized Paper

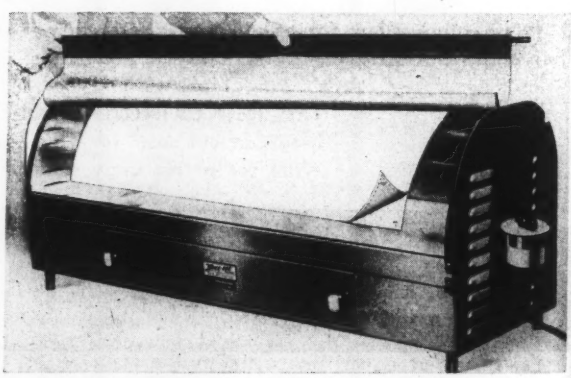
Line drawings, typewritten material and pictorial transparencies are reproduced with equal effectiveness on Tecnilux plastic-coated ammonia-developing paper in whiteprinting machines. Sensitizing materials do not penetrate into fiber of paper, but image is formed wholly within plastic coating to give brilliant sharply defined dense line against clean white background. Manufacturer: Tecnifax Corp., Holyoke, Mass.

For additional information circle MD 41 on Page 173

Whiteprinter

Employing Diazo process to produce positive-reading prints, Spee-Dee whiteprinter delivers accurate black-on-white or blue-on-white positive prints from transparencies or opaque originals. Any written, printed or photographed matter can be reproduced by this equipment, which prints sheets 24 x 36-in., and is available also in 12 x 8 and 18 x 24-in. sizes. Sturdily constructed machine operates from standard 110-volt ac outlet and is portable. Weighing 58 lb, unit measures 38 in. wide, 16 in. deep and 15½ in. high. Light source is four 250-w and two 500-w bulbs. Manufacturer: Peck & Harvey, 5736 N. Western Ave., Chicago 45, Ill.

For additional information circle MD 42 on Page 173



REVOLUTION ON THE RAILROAD

New-type train designed for more comfort and safety is cushioned on U. S. Rubber Mountings

SWING LOW, SWEET CHARIOT! This new short-car, low-slung "Talgo" experimental train* really hugs the road. Each short, articulated unit has special parts designed by U. S. Rubber to cushion passengers against noise, vibration and shock. It's like riding on air.

SEEING EYE TO EYE are these passengers and the persons standing outside. Low center of gravity makes for more stability. Each car has only 2 wheels, is supported by U. S. Rubber Special Coupling unit on the car ahead.

INSIDE STUFF. Specifically designed U. S. Rubber parts are used in this wheel assembly and spring suspension. They give a smoother, quieter, safer ride. You can't beat rubber and "U. S." experience on jobs like this.

The "Talgo" train is another example of a manufacturer handing a problem to U. S. Rubber Company engineers and letting them apply their research data and facilities to the job. It will pay you to take advantage of "U. S." experience and advice. Write for free new brochure, "This is Your Laboratory." It tells about U. S. Rubber's vast new research facilities at Fort Wayne.

*(3 built to date)

A PRODUCT OF

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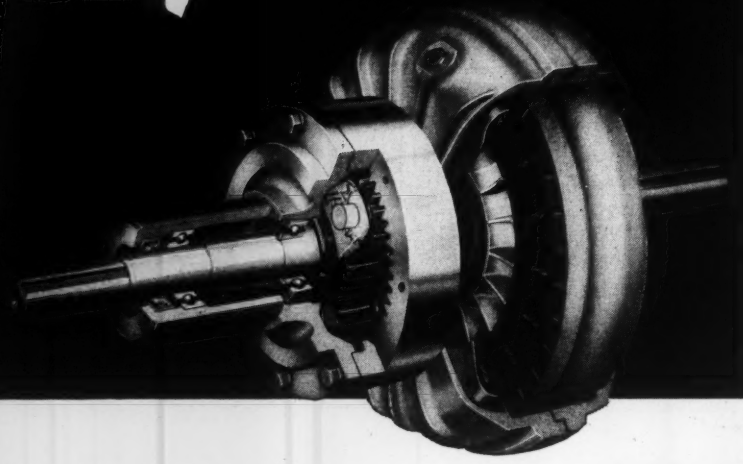
UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Twin Disc Announces the Hydro-Wynd for Constant Tension Wind-up



For winding applications in:

Textile Industries

Printing Processes

Paper-Making Machinery

. . . Wherever roll diameters vary and constant lineal speed and tension are required.

The Hydro-Wynd combines an hydraulic coupling with a planetary gearset to mastermind the delicate job of maintaining predetermined tension and speed on wind-up applications, *without constant adjustments*.

In order to maintain constant speed and constant tension on the material to be wound, the Hydro-Wynd automatically balances speed-torque requirements in the drive to the spool shaft—eliminates the need for constant manual control.

See your Twin Disc Dealer for full information about the new Hydro-Wynd for *your* winding application, whether it's wire, plastic, thread, paper or yarn. Currently available Hydro-Wynd units, singly or in compound, are capable of handling up to 7.5 horsepower.

Uniform tension held automatically throughout roll build-up—convenient operator control of tension over a wide speed range—high quality cloth—reduced safety hazard: that's the performance report on a Hydro-Wynd installed on a Morrison Tenter Frame in a large Southern textile finishing mill.

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

Clutches & Hydraulic Drives

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

BRANCH OFFICES: CLEVELAND • DALLAS • LOS ANGELES • NEWARK • NEW ORLEANS • SEATTLE • TULSA

HELPFUL LITERATURE

FOR DESIGN EXECUTIVES

75. Hydraulic Remote Controls
Sperry Products, Inc. — 8-page illustrated bulletin No. 20-105 describes two series of remote controls for industrial use and available accessories including intermediate transmitter for use at secondary control stations. Controls feature use of single line up to 200 ft long for connecting transmitter and receiver and easy synchronization.

76. Herringbone Gear Reducers
De Laval Steam Turbine Co.—28-page illustrated bulletin H-HS covers line of heavy-duty herringbone gear reducers for capacities up to 1000 hp. It contains complete descriptions of single, double and triple reduction units; horsepower rating tables for standard and semihigh-speed units, overhung load rating tables, dimensions and weights.

77. Pipe Line Thermometer
Bristol Co.—6-page illustrated bulletin No. T843 deals with pipe-line recording thermometers for natural and manufactured gas temperatures. Photographs and drawings show methods of application, and typical chart record is included.

78. Electrical Resolvers
Arma Corp. — 12-page illustrated booklet "Arma Electrical Resolvers" presents information on eight miniature electrical resolvers and seven other types in two size groups developed particularly for electromechanical computing and control equipment.

79. Rubber & Synthetics
Connecticut Hard Rubber Co.—8-page illustrated circular "Cohrlastic Rubber & Synthetics" shows examples of bonded rubber-to-metal parts, gaskets and diaphragms, molded parts, silicone rubber products for temperatures from —70 to 450° F, extrusions and coated fabrics.

80. Chains & Couplings
Ramsey Chain Co.—62-page illustrated catalog No. 650 contains list prices and engineering information on design and application of silent chain drives and flexible couplings. Among advantages of line are elimination of slippage and friction, smooth flow of power, high speed operation, compact construction and adaptability to speed changes.

81. Bimetal Strip Thermostats
Stevens Mfg. Co.—Illustrated leaflet on type R bimetal strip thermostats for use in appliances, industrial apparatus and electronic equipment contains schematic diagram of operating principle, typical thermostat response curve, cutaway view of unit and photograph showing various standard designs.

82. Steel Castings
Steel Founders' Society of America—4-page illustrated folder "Product Design Studies" No. 25 relates how cost was reduced, appearance improved and dependability assured by conversion to steel casting for tractor axle part.

83. Screw & Washer Assemblies
Eaton Mfg. Co., Reliance Div.—40-page illustrated engineering folder S 49 contains information on Springtites and Sems screw or bolt and washer assemblies designed to reduce labor and speed up production. Dimensions of units with round, fillister, pan, truss, hex and flat heads are presented.

84. Electric Weld Pipe
Republic Steel Corp. — 20-page illustrated booklet form ADV-521 on pipe made by electric resistance weld method contains detailed description of manufacturing process and outlines advantages. Structural and mechanical application of product ranging from hot water heater flues to boom and dipper sticks for power shovels are discussed.

85. Air Valve
Westinghouse Air Brake Co.—1-page illustrated catalog sheet IDA 9457-1 depicts Tite-Air valve for on-off operation of single-acting cylinder. Valve measures 2⅞ x 3⅝ x 8½ in., weighs 4 lb and is designed for ¼-in. pipe taps.

86. Oil-Hydraulic Pumps
Denison Engineering Co.—Illustrated bulletins Nos. P-4, P-4-1, P-4-2, P-4-3 and P-4-10 deal with series 600, 700 and 800 constant and variable volume Hydrolic pumps. Rated at 5000 psi, they are available in types and sizes for many different industrial needs.

87. Miniature Ball Bearings
Landis & Gyr, Inc.—12-page illustrated bulletin shows how small pivot and various other types of tiny radial ball bearings should be mounted for such applications as precision instruments, aircraft accessories and apparatus having small moving parts.

88. Air & Hydraulic Units
Rivett Lathe & Grinder Inc.—8-page illustrated form 4-50-SP presents complete line of Gerotor air and hydraulic cylinders and valves and hydraulic power units available in sizes and types for requirements of entire air or hydraulic circuit.

89. Industrial Machinery
Zagar Tool, Inc.—28-page illustrated catalog No. 10 presents dimensional drawings on all models of collet fixtures, broaching machines and multiple spindle gearless drill heads. Included are data sheets on new keyway broach standards for 20 and 36-in. horizontal broaching machines.

90. Balancing Machines
R. B. Annis Co.—4-page illustrated circular "Annis Balancing Machines" deals with Dynograph balancer which is precision electronic device for locating and measuring two separate components of dynamic unbalance. Both amount and position of unbalance in rotating parts are determined quickly through single reading of trace on cathode ray tube.

91. Molded Oil Seal
Johns-Manville Corp. — 16-page illustrated bulletin PK-46A describes Clipper oil seal that is precision molded for accurate fit and long life. Seal has tough dense heel and soft flexible lip concentrically molded into one piece. Many applications for this device are shown.

92. Business Machine Motors
General Electric Co.—8-page illustrated bulletin GEA-5420 describes features and advantages of fractional horsepower motors for typewriters, adding machines, calculators and portable accounting machines. Construction, performance, characteristics and ratings are discussed also.

93. Retaining Rings
Waldes Kohinoor, Inc. — 8-page illustrated bulletin No. 5 covers series of Truare self-locking rings that require no groove for installation or assembly on shafts or in housings where conditions of impact and vibration are not excessive.

94. Compression Molding Compound
Libbey-Owens-Ford Glass Co., Plaskon Div. —4-page illustrated folder form No. 7131 discusses Plaskon Alkyd mineral-filled molding material which is suited to small compact dies installed in fast closing air or hydraulic presses. It has good dimensional stability and resistance to solvents, chemicals and heat.

FOR MORE INFORMATION

on developments in "New Parts" and "Engineering Department" sections—or if "Helpful Literature" is desired—circle corresponding numbers on either card below

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95. Valves & Cylinders

Galland-Henning Mfg. Co.—32-page illustrated bulletin No. 100 contains data on Nopak nonrotating cylinders for air or hydraulic service; air, oil or water valves for pressures up to 250 psi and hydraulic valves for pressures up to 1500 psi. Cylinders are available in standard tubing and tierod, recessed head, heavy-duty, and high pressure hydraulic constructions.

96. Precision Metal Parts

Torrington Co.—28-page illustated catalog lists various precision metal parts that can be made to order. Included are closed and open-end awls, divider and caliper leg blanks, drills for cloth cutting machines, electrodes for oil burners, ice pick blades, mandrels, special needles and many related items.

97. Copying Machine

General Aniline & Film Corp., Ozalid Div.—6-page illustrated folder describes Streamliner all-purpose machine for copying typed, written, drawn, printed and photographed work. Machine accommodates materials up to 42 in. wide at printing speed of up to 10 fpm and developing speed of 5 fpm.

98. Production Welding

Eutectic Welding Alloys Corp.—8-page illustrated brochure Vol. 6 No. 7 relates 15 production welding case histories. Such problems as finishing costs, scaling, distortion, softening of heat-treated metals, burn-through, weld failure from impact, and joining of dissimilar metals are examined.

99. Air Line Lubricators

M-B Products—4-page illustrated bulletin No. 1008-A-C covers automatic air line lubricators and filters in ¼ and ⅜-in. NPT sizes for lubricating tools and machines operated by compressed air.

100. Bridge Switch

Brush Development Co.—8-page bulletin No. 4, volume III explains how model BL-312 Universal Bridge switch has been developed to extend range of BL-320 Universal Amplifier used in making strain measurements of various types of structures. This switch contains six separate control panels which include attenuator, resistance balance, capacity balance, fine gain control and calibration control.

101. Fastenings

Tinnerman Products Inc.—First volume of case histories describing cost reductions provided by Speed Nut products is entitled "Speed Nut Savings Stories." Contained in booklet are 14 accounts of how various well-known companies are using Speed Nuts, Speed Clips or Speed Clamps.

102. Air-Hydraulic Coupler

Snap-Tite, Inc.—3-page illustrated Vol. 1, No. 2, of "Snap-Tite Bulletin" presents ¾-in. automatic shutoff coupler designed for air and water. Quick-disconnect unit is also available in types for low pressure handling of oil and grease.

103. Coolant & Lubricant Pumps

Pioneer Pump & Mfg. Co.—16-page illustrated publication "Pump Engineering Manual" describes various types of belt, chain and gear driven coolant and lubricant pumps designed to conform with latest JIC regulations. Sizes range from 0 to 174 gpm.

104. Cold-Drawn Shapes

Rathbone Corp.—16-page illustrated brochure "The Rathbone Process" deals with production of special formations or shapes in metal bars by cold drawing. Shapes can be pinion or gear profiles, or contour of part can have any symmetrical or irregular shape.

105. Drafting Templates

Rapidesign, Inc.—8-page illustrated catalog No. 50 depicts and describes 30 types of templates for use by draftsmen, engineers, architects and designers. Typical made-to-order templates are shown, and prices of all types are listed.

106. Springs & Formed Wires

Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—28-page illustrated manual is entitled "Springs & Formed Wires." It depicts and describes extension, compression, torsion and flat wire springs as well as variety of formed wire shapes.

107. Press Brake Dies

Cyril Bath Co.—48-page illustrated catalog D-50 covers wide variety of press brake dies including curling, beading, seaming, offsetting, hemming, channel bending, acute angle, multiple punching and special purpose types. Also included is section on piercing tooling.

108. Flexible Couplings

Falk Corp.—8-page illustrated bulletin 8100 is descriptive of Airflex couplings which protect driving and driven machinery from effects of frequent high torque fluctuations and impact by virtue of their inherent resilience. Special sections are devoted to methods of selection for engine driven systems and for systems involving shock.

109. Locknuts

Townsend Co.—Sample card illustrates assembly of Tufflok nut which consists of one-piece cold forged nut and treated hexagon insert. Four sample nuts are attached to card for inspection. Fasteners can be obtained in machine screw sizes No. 4 through ⅜-in., cadmium or zinc plated, brass or aluminum.

110. Engraving Machine

New Hermes, Inc.—20-page illustrated booklet "Tracer Guided Engraving" deals with model IM Engravograph designed for rapid and accurate engraving in commercial and industrial fields. Machine can be used on plastic, wood, brass, bronze, aluminum, steel, glass, mother of pearl and onyx.

111. Testing & Research Facilities

United States Testing Co.—114-page illustrated booklet "Testing & Research in Modern Industry" presents information on scope of organization's activities and facilities for testing material, equipment, products and merchandise. Many useful weight and measure, textile, chemical and engineering tables are included.

112. Carbon Steel Tubing

Babcock & Wilcox Tube Co.—6-page illustrated bulletin TB-333 covers ERW carbon steel mechanical tubing available in sizes from ⅝ to 4-in. OD in variety of lengths and wall thicknesses. It can be formed, bent, machined and welded for adaptation to many mechanical applications.

113. Detachable Couplers

Foster Mfg. Co.—8-page illustrated pamphlet and price list on Chrome Sleeve quick-detachable couplers for pipe and hose connections presents sizes, prices and construction details of these units for handling air, oil or grease. Slight movement of sleeve is all that is required to connect or disconnect line.

114. Plastic And Rubber Parts

Ohio Rubber Co.—4-page illustrated circular "Plastics? Yes! Rubber? Yes!" tells of compounding and injection molding service and complete facilities for producing rubber and synthetic rubber parts.

115. Electrical Connectors

Bendix Aviation Corp., Scintilla Magneto Div.—8-page illustrated folder form L-321 contains data on type AN electric connectors. They are shock and vibration resistant because Scinflex inserts and contacts are held firmly in shell and because conductors can be supported at solder well by Scinflex grommet.

116. Small Electric Motors

Barber-Colman Co.—36-page folder file F-3563 depicts and describes Barcol unidirectional, reversible, synchronous and geared electric motors which are suitable for use in instruments, appliances, advertising devices, communication and projection equipment, and toys.

117. Roller Gear Drives

Ferguson Machine & Tool Co.—8-page illustrated leaflet "Precision Can Cut Costs" outlines features of roller gear drives available for dial drives with any number of stops from two and up per revolution, indexing period from less than 90 to more than 270 degrees of driving shaft, and right or left-hand rotation.

118. Mechanical Vibrating Conveyor

Jeffrey Mfg. Co.—4-page illustrated bulletin No. 826 portrays type MV mechanical vibrating conveyor which operates on system of balanced forces. It will convey coarse or fine materials at controlled depths horisontally and at angles up to 10 degrees.

119. Stainless Steel

Armco Steel Corp.—12-page booklet "Stainless Steels for Heat Resistance" presents concise discussion of properties of stainless steel and outlines proper grades to use for parts subjected to heat. Graphs show relative scaling resistance, high temperature tensile strength, creep strength and high temperature rupture strength of various grades.

120. Automatic Lubrication

C. A. Norgren Co.—8-page illustrated folder No. 424 depicts how tools, cylinders and machines can be lubricated automatically with air-borne oil fog. Equipment listed includes relief valves, check valves, air governors, blow guns, hose connections, couplings and assemblies and various combination lubricators.

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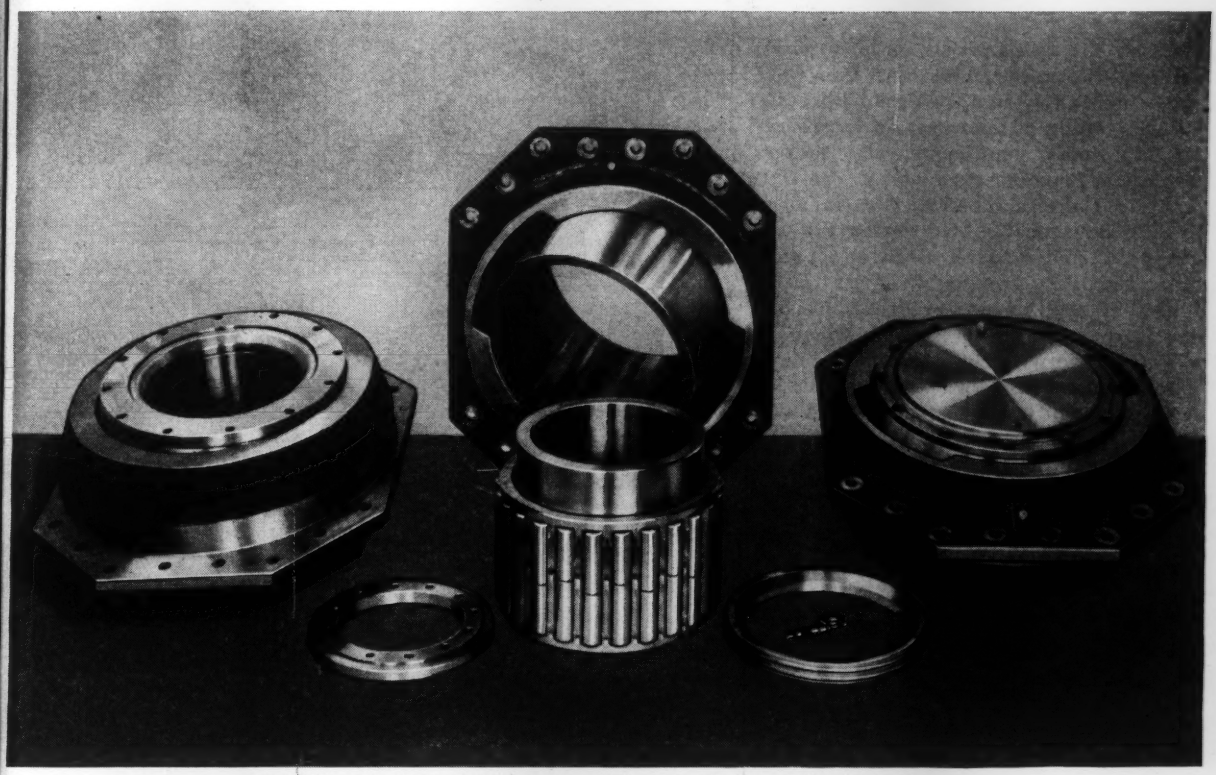
XUM

Big, Busy, Bascule Bridge

at Two Rivers, Wisconsin

designed to pull smoothly on KAYDON bearings



KAYDON RADIAL ROLLER BEARINGS 12.000" x 22.000" x 10.750", with housings

Engineers who designed the new bascule bridge at Two Rivers, Wisconsin, found **KAYDON** well prepared to meet their demands for four big, husky, compact, radial bearings, with housings, as shown here.

KAYDON specializes in bearings designed for specific duties . . . and **KAYDON** has *all* the facilities for producing them. Whatever your bearing problem may be . . . whether it involves a few specially designed, heavy-duty bearings 4" to 120" outside diameter, or millions of high precision needle rollers . . . contact **KAYDON** of Muskegon for dependable counsel, in confidence.

★ ★ ★

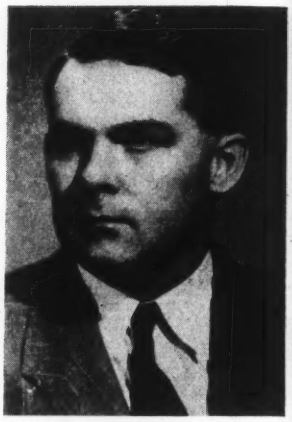
ALSO INVESTIGATE NEW KAYDON TECHNIQUES for hardening raceways only, thus permitting the races themselves to be drilled, tapped, and in some cases, gear cut. Better bearing efficiency in restricted space is assured . . . surrounding parts can be eliminated . . . important weight-reduction is accomplished.

KAYDON Types of Standard or Special Bearings: Spherical Roller • Taper Roller • Ball Radial • Ball Thrust • Roller Radial • Roller Thrust

THE KAYDON ENGINEERING CORP., MUSKEGON, MICH.

• ALL TYPES OF BALL AND ROLLER BEARINGS 4" BORE TO 120" OUTSIDE DIAMETER •

MEN OF MACHINES

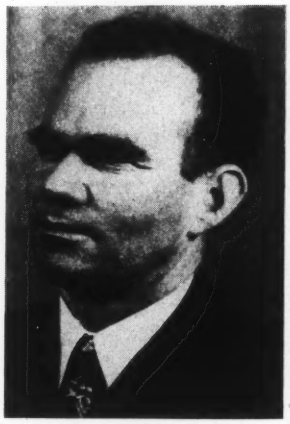


William M. Cade

Robert F. Schlitzkus has recently joined Marchant Calculating Machine Co., Oakland, Calif. His new responsibilities include the study of improvement in production machinery and equipment. A mechanical engineering graduate of The University of California, he was first employed by S. T. Johnson Co., and during the war served the United States Army as an antiaircraft artillery group staff officer. Early in 1946 he was engaged by Production Engineering Co. as chief engineer where he was concerned with the design of a line of cotton spinning machinery, with production of a set of pilot model machinery, and with the design and production of power tools sold through a leading mail order house. In his present capacity in charge of special production machine design he will supervise the design of special machinery suitable for business machine manufacture.

Robert F. Schlitzkus

♦



William T. Bean

William M. Cade has been named chief engineer of French & Hecht Division, Kelsey-Hayes Wheel Co., Davenport, Iowa. Mr. Cade has been with French & Hecht slightly more than a year as design engineer, having transferred to the local organization from the John Deere Tractor Works in Dubuque where he had been employed for three years in tractor design and development. From September 1940 to January 1942 he was a civil engineering instructor at the University of Hawaii and during part of that period was stress engineer in the U. S. Engineer's Office at Honolulu. He served as a reserve officer from January 1942 to October 1945, being assistant to the department engineer in Honolulu the first six months of 1942 and as aeronautical engineer at Wright Field the remainder of that time.

♦

Industrial Electronics Inc., Detroit, announces the formation of a new Technical Service Center with **William T. Bean** as director. Mr. Bean, internationally known authority on experimental stress analysis, was previously in charge of the stress analysis laboratory of the research division of Continental Motors. He also served as project engineer on air-cooled engine development for Army Ordnance. A mechanical engineering graduate of the University of Oklahoma, he began his career with the Skelly Oil Co. of Texas as a petroleum engineer engaging in production engineering, oil treatment, and well pressure measurement and later joined the National Supply Co.

♦

Roy J. Sandstrom

Announcement has been made of the appointment of **Roy J. Sandstrom** as chief engineer of Bell Aircraft Corp., Buffalo. Since May, 1948 Mr. Sand-

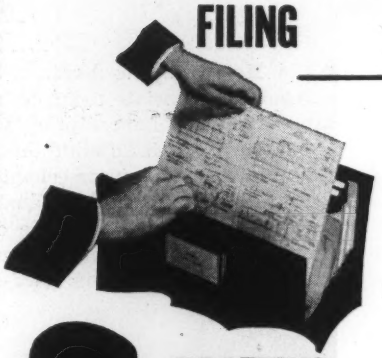
XUM

At the Crompton & Knowles Looms Works
WORCESTER, MASS.

3 engineering department routines simplified

with Kodagraph Autopositive Paper

FILING



A low-cost, photographic intermediate paper that produced positive copies directly was "big news" for Crompton & Knowles, world's largest manufacturer of specialty looms. To begin with, it meant that they could reorganize their filing system much faster and much more economically than had been estimated. *Here was the problem:* they had some 200,000 detail drawings—4 to 8 on each sheet of paper. Many of these were not in sequence, which slowed reference; and, when blueprints of only one part were needed, it meant a waste of paper . . . besides taking the attached drawings out of the files. *Solution:* the design sheets were reproduced on Kodagraph Autopositive Paper; then the prints were cut and filed correctly in the "master" file.

★ ★ ★

DRAFTING

Crompton & Knowles has adopted the rule: *"A Kodagraph Autopositive intermediate of every drawing."* And this is paying off today in lower re-drafting costs. *Before,* the original detail drawings (described above) and scale drawings were used as the blueprint "masters" . . . were exposed to machine wear-and-tear, constant handling. When they no longer produced legible blueprints, they had to be redrawn. *Now* the valuable originals are kept safe in the files—available for reference and revisions only. The "Autopositives" do the "heavy work" . . . whenever needed.

★ ★ ★

PRINT PRODUCTION

Using Kodagraph Autopositive intermediates, Crompton & Knowles turns out sharper, cleaner blueprints—at uniform, practical machine speeds.

That's because these new intermediates have an evenly translucent, high-quality paper base . . . and dense photographic black lines which will not smudge or lose opacity even after hundreds of trips through the machine.

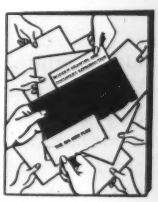
How "Autopositives" are produced: Crompton & Knowles uses its blueprint machine for exposure; standard photographic solutions for processing. In this manner it gets positive copies directly—without a negative step . . . without darkroom handling.

Kodagraph Autopositive Paper

"THE BIG NEW PLUS" in engineering drawing reproduction

- **It enables you, or your local blueprinter, to produce positive photographic intermediates at a new low cost.**
- **It preserves valuable originals . . . cuts redrafting costs.**
- **It restores old, soiled drawings . . . gives you cleaner, sharper prints.**
- **It gives you photo-lasting file copies.**

A new illustrated booklet,* "Modern Drawing and Document Reproduction," gives all the facts on this revolutionary photographic intermediate. *It's free. Just mail the coupon.



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Industrial Photographic Division
Rochester 4, N. Y.

19

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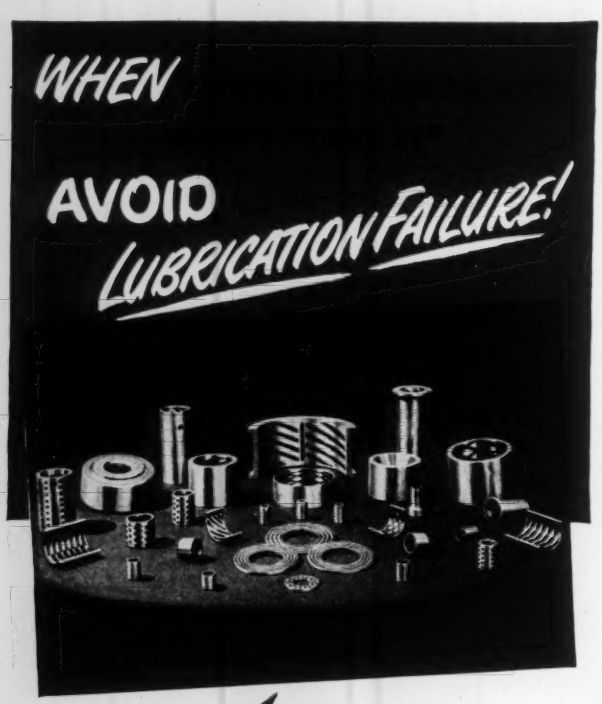


LOOK Into **BOUND BROOK**

Graphited Bronze Bearings

for these tough jobs:

HOISTS • TRUCKS • CONVEYORS

PUMPS • BRIDGES • PLOWS

ELEVATORS • TRACTORS

BUSES • MACHINE TOOLS

and many other heavy-duty, hard-to-lubricate jobs

BOUND BROOK Graphited Bronze Bearings are built to withstand cold, heat, dust, mud, water and chemicals. Shafts turn freely, day in, day out, on a smooth thin film of graphite lubricant. Maintenance costs go down —service without maintenance goes up.

Cast bronze, inlaid with graphite.

CONSULT OUR ENGINEERS

BOUND BROOK "COMPO" • "POWDIRON" • BOUND BROOK

strom served as executive chief engineer. Prior to that, he was chief of Bell's technical services in charge of all military engineering work and at one time was project engineer on the supersonic X-1. A graduate of the University of Michigan in aeronautical engineering, he was employed by the airplane division of Curtiss Wright and Lockheed until 1938 when he went to work at Bell.

♦

Albert C. Hall of the Massachusetts Institute of Technology has been appointed associate technical director of Bendix Aviation Research Laboratories, Detroit. Dr. Hall, who has been on MIT's staff for 13 years, is a recognized authority on servomechanics. Since 1946 he has been director of the dynamic analysis and control laboratory of the Institute. He developed the nation's first scientific flight simulator and a control system for the first guided missile used by the Navy.

♦

Link Aviation Inc., Binghamton, N. Y. announces the appointments of **J. F. Newlon** as manager of manufacturing engineering and **J. F. Miller** as plant superintendent.

♦

C. Stewart Ferguson, who has been associated with General Electric Co. for 31 years, has been appointed technical director of Marshall-Eclipse Division of Bendix Aviation Corp., Troy, N. Y. A graduate of Rensselaer Polytechnic Institute he has been a chemist in GE's research laboratories, a design engineer, and engineer in charge of what formerly was the company's resin and insulation materials division.

♦

Maynard T. Murray has been named manufacturing manager of the general manufacturing division, Ford Motor Co., Dearborn, Mich. He served the division as manager of quality control and, more recently, as acting manager of the Canton, O. forge plant. **Burton O. Heinrich,** former assistant manager, Canton plant, succeeds Mr. Murray.

♦

Ronald B. Smith, who joined the M. W. Kellogg Co., New York, in 1948 as director of engineering, has recently been named a vice president of the company. He is a consultant to the Atomic Energy Commission and a member of the National Advisory Committee for Aeronautics.

♦

Christiansen Corp., Chicago, has named **Walter Bonsack** as vice president and director of research. He will be responsible for the correlation of the extensive aluminum research program and will be in charge of the technical operations and procedures of

"Caterpillar" Hydraulic Controls

Use VICKERS BALANCED VANE PUMPS

Caterpillar No. 46 and No. 44 Hydraulic Controls use Vickers Balanced Vane Type Pumps for their dependable source of hydraulic power. These front mounted controls have a world-wide reputation for responsiveness, reliability, low maintenance and minimum down-time.

Vickers Vane Pumps have many advantages in addition to the hydraulic balance and cartridge assembly illustrated below. Their initial high operating efficiency continues because correct running clearances are automatically maintained. The no-load starting characteristic is an important feature in cold weather. Space requirement is small in proportion to hydraulic output. Working pressure is up to 1000 psi (continuous duty). Write for Bulletin 36-12 and Bulletin 49-52, which illustrate and describe the advantages of Vickers Vane Pumps for mobile equipment.

TO HELP ASSURE:

Fast, Responsive Control

•

Long, Reliable Service

•

Minimum Maintenance and Down-Time

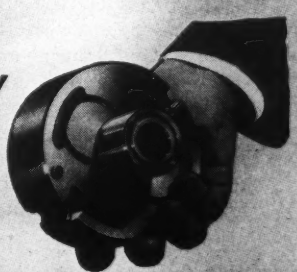
•

VICKERS Incorporated
DIVISION OF THE SPERRY CORP.
1430 OAKMAN BOULEVARD • DETROIT 32, MICHIGAN
Application Engineering Offices: ATLANTA • CHICAGO • CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES (Metropolitan) • MILWAUKEE NEW YORK (Metropolitan) • PHILADELPHIA • PITTSBURGH • ROCHESTER ROCKFORD • ST. LOUIS • SEATTLE • TULSA • WASHINGTON • WORCESTER

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

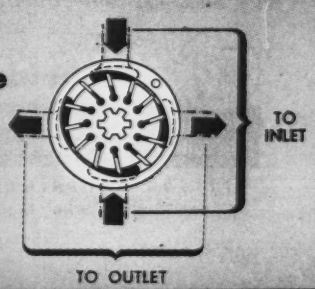
3984

VICKERS Cartridge Assembly



This cartridge contains all the pumping parts that move . . . none of them contact the housing. Inspection and removal of all working parts can be made without disconnecting piping or drive coupling.

VICKERS Hydraulic Balance



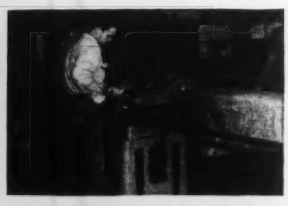
With this patented construction, bearing loads are cancelled out by equal and opposing radial hydraulic thrust loads as shown in diagram. The result is longer pump life with minimum maintenance.

At your Service

ON WIRE AND METAL ASSEMBLIES

CAMBRIDGE offers the most modern fabricating facilities plus years of engineering experience

. . . to make any wire and sheet metal tray, rack, basket, fixture, crate, screen or other fabrication you need to reduce costs and speed-up material handling, processing and treating. The fact that Cambridge is equipped to perform every step of the designing and manufacturing assures you of the famous Cambridge quality and service on all items, regardless of size or quantity.



Your Cambridge field engineer can recommend the right design and construction, and the proper metal or alloy for washing, spraying, dipping and similar operations.

Or write direct for information on the complete Cambridge facilities. Send for this FREE illustrated folder describing Cambridge wire baskets and specialties.

Cambridge Wire Cloth Co.

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Wire cloth in rolls. | Any metal or alloy, mesh or weave.

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all of their plants. Mr. Bonsack, an authority on light metals and their foundry use, holds a number of patents in this country and abroad on aluminum alloys, heat treatment, fluxes and fluxing processes, special type melting furnaces and refining methods.

♦

Robert C. Blackinton has been appointed to the position of plant manager of the Pioneer Engineering and Manufacturing Co., Detroit. Recently he was associated with Federal Telephone and Radio Corp. as vice president in charge of manufacturing. From 1942 to 1946 he was manager of the special ordnance division of Blaw-Knox Co. While with Cadillac and Pontiac Motor Divisions of General Motors he had supervision of such activities as tool design, plant layout, time study, quality control, and product design.

♦

Appointment of **Gordon C. Harvey** as division engineer of ballast engineering has been announced by General Electric Co. He joined General Electric in 1931 after graduating from Ohio State University, and in 1936 was assigned to the engineering section of the fractional horsepower motor divisions at Fort Wayne. In 1945 he was transferred to the Decatur plant, returning to Fort Wayne two years later to become assistant section engineer of the ballast engineering division, the position he retained until his present appointment.

♦

A. O. Schaefer was recently elected vice president in charge of engineering and manufacturing, Midvale Co., Nicetown, Philadelphia. He joined the company in 1922 and served successively as research associate, assistant production manager, engineer of tests and executive metallurgical engineer.

♦

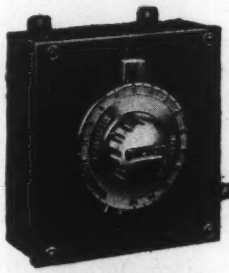
Isaac Harter, chairman of the board of the Babcock & Wilcox Tube Co., Beaver Falls, Pa., has been named a Fellow of The American Society of Mechanical Engineers. During his long association with The Babcock & Wilcox Co. Mr. Harter made many significant contributions to industrial progress. He became an associate member of the ASME in 1908 and in 1921 was made a full member. Elevation to the grade of Fellow is by election of the ASME Council, supreme governing body of the Society.

♦

Metal Products Division of Koppers Co. Inc., Pittsburgh, announces the appointment of **Earl V. Harlow** as engineering assistant to **Walter F. Perkins,** vice president and general manager. Formerly associated with Koppers central research department, Mr. Harlow in his new capacity will be responsible for assisting and advising the division general manager on engineering matters and for co-ordinating research and development projects between the division and the research department.

Here is the BALDOR *Simplified* ADJUSTABLE SPEED MOTOR *System*

for innumerable applications

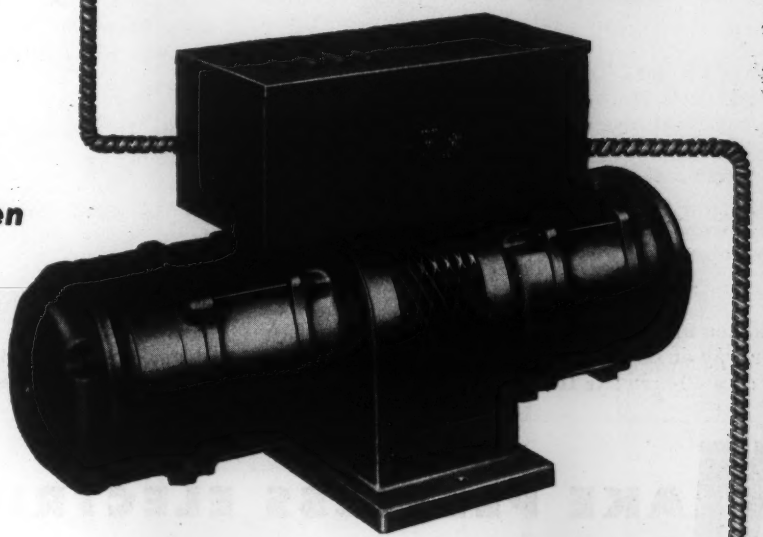


CONTROL UNIT
—place it anywhere

from 0 to 2400 r.p.m., and selected speeds in-between

•

dynamic braking and instant reversing



WIDER RANGE OF SPEEDS — from 0 to 2400 r. p. m., and intermediate speeds, quickly and positively. (16 steps forward; 16 steps reverse.)

FULL TORQUE—constant speed at each speed setting.

RAPID, SMOOTH SPEED CHANGE—even from full forward to full reverse. One simple control provides smooth speed changes and dynamic braking.

SEPARATE UNITS permit convenient, economical application and installation, either near-by or remote operation.

SIZES: ¾ hp., thru 1½ hp., Single Phase
¾ hp., thru 3 hp., Three Phase

Baldor Motors are sold and serviced NATIONALLY in over 300 trade centers

BALDOR ELECTRIC CO., ST. LOUIS 10, MO.

Motor Specialists for 30 years

Another **Baldor** MOTOR DEVELOPMENT

ASK for complete, detailed data.

The Baldor Streamcooled Motor is TOTALLY ENCLOSED, cooled by externally-mounted fan. It can't clog.

NEWS
OF MANUFACTURERS

Potter Instrument Co. Inc. is transferring its operations to a newly constructed plant at 115 Cutter Mill Road, Great Neck, L. I. Formerly located at Flushing, N. Y., Potter manufactures high-speed electronic counters, precision counter-chronographs, electronic computers and associated equipment.

♦

Hardinge Co. Inc., York, Pa., has signed a contract with the **Ellicott Machine Corp.**, Baltimore, Md., giving Hardinge exclusive manufacturing and sales rights for the Kuntz lime and hydrate equipment. The two major pieces of Kuntz equipment which will be built and sold by Hardinge under this contract are the continuous feed automatic type lime kiln and the lime hydrator.

♦

Construction of new **Armstrong Cork Co.** laboratories is under way at Lancaster, Pa. The research buildings will be on a 40-acre site four miles west of Lancaster, location of the home offices of the company. It is expected that the new facilities will be ready for use early in 1951.

♦

Sneller Machine & Tool Co., Cleveland, O., has purchased the building and property at 15002 Woodworth Rd., Cleveland, O. This acquisition permits Sneller Machine to double its machining and assembly facilities for the manufacture of special machines and mechanical units.

♦

Process Industries Engineers Inc. has formed a manufacturing division for the fabrication of specially engineered equipment for the chemical, petroleum, food, and allied industries. The company will continue operations of the engineering and sales divisions at 5941 Baum Blvd., Pittsburgh, Pa.

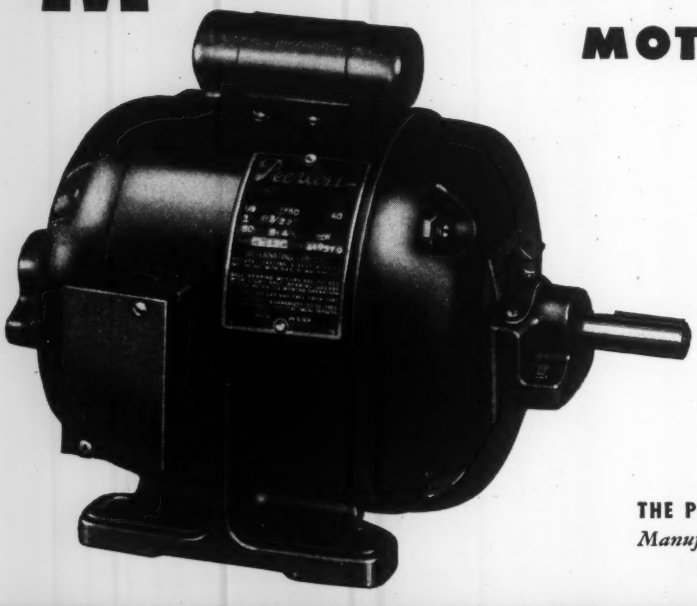
♦

The DeVilbiss Co., Toledo, O., has opened a new assembly, storage and distribution plant in Santa Clara, Calif. The company manufactures a complete line of spray painting equipment—air compressors, hose, spray paint booths, atomizers, and related equipment.

♦

Automatic Steel Products Inc., Canton, O., has taken over the active management of **The Cleveland Tapping Machine Co.**, Hartville, O. Operation will be

MAKE PEERLESS ELECTRIC *your* MOTOR DEPARTMENT



● When you bring your motor problems to Peerless Electric, you add a motor department to your plant facilities. Peerless is small enough to give individual engineering attention to your motor requirements—large enough to manufacture the motors you need in any quantity.

We can give you the same quick action on special motors that you could get in your own plant if you had a motor department —action that will give you promptly the information or samples you may need.

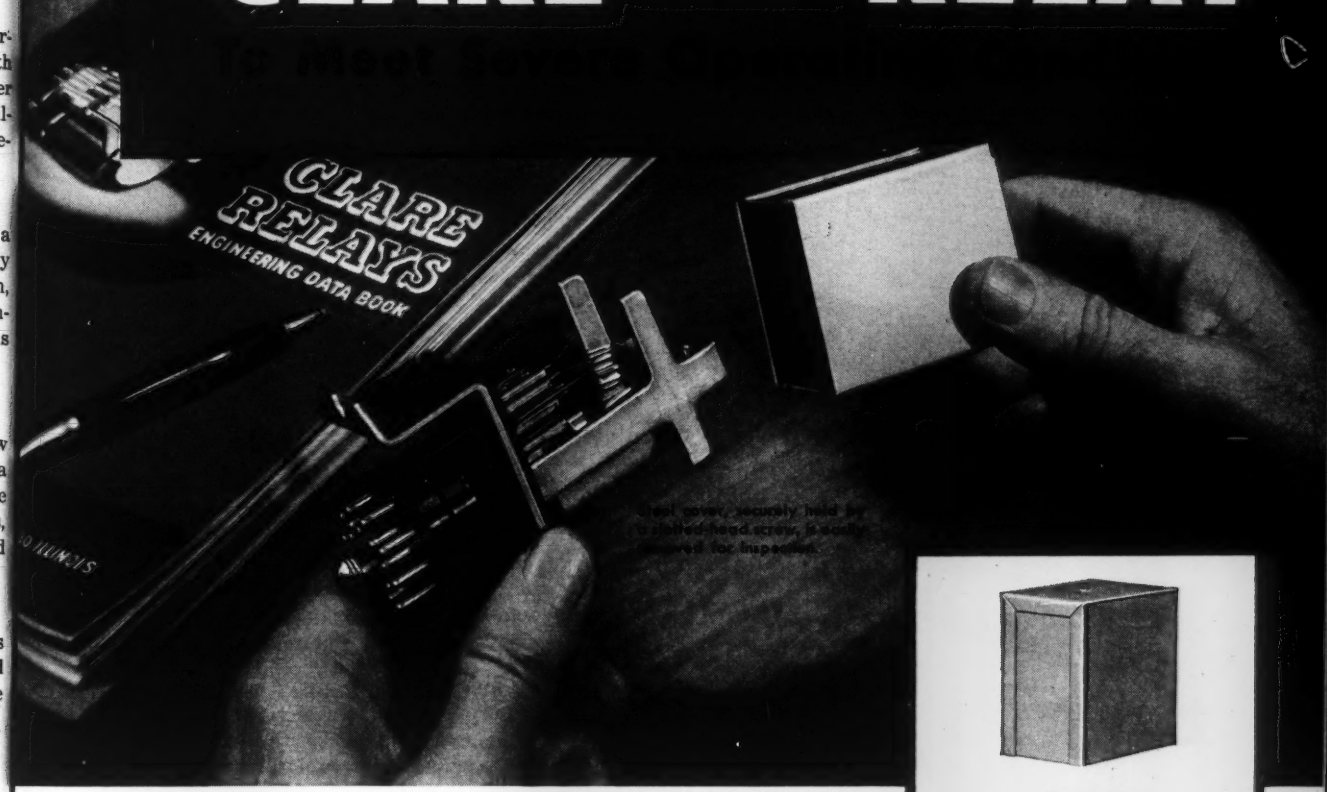
THE PEERLESS ELECTRIC COMPANY • WARREN, OHIO

Manufacturers of Quality Motors for more than 55 years.

Single Phase • Polyphase • Direct Current Motors

ALL *Peerless Motors* ARE "PEERLESS REGISTERED"

CLARE TYPE "J" TWIN CONTACT RELAY



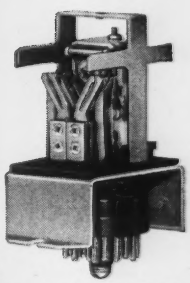
● This new CLARE dust-tight plug-in enclosure for the small Type "J" Relay offers designers a number of unusual features for installation on industrial equipment.

Entrance of dust is prevented by the steel cover and by use of a Neoprene gasket which is closely fitted at the factory to the relay terminals. The dust-tight cover is easily removed for inspection. Use of standard radio plug simplifies installation and cuts wiring costs. Base is secured to chassis to prevent plug from being jarred or accidentally pulled from its socket.

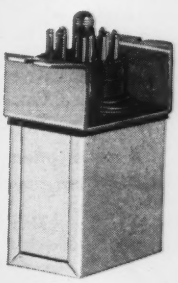
Exclusive design of the CLARE Type "J" Relay allows the twin contacts to operate independently of each other. One contact is sure to close, reducing contact failure to the practical limit. This relay combines all the best features of the conventional telephone-type relay with small size and light weight. It provides unusually high current-carrying capacity, large contact spring capacity, extreme sensitivity and high operating speed.

This new dust-tight enclosed relay is one of many outstanding CLARE contributions in the development of new and better relay components for industry. CLARE Sales Engineers are located in principal cities to consult with you on your relay problems. Call them direct or write: C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. Cable Address: CLARELAY. In Canada: Canadian Line Materials Ltd., Toronto 13.

Write for Bulletin No. 108

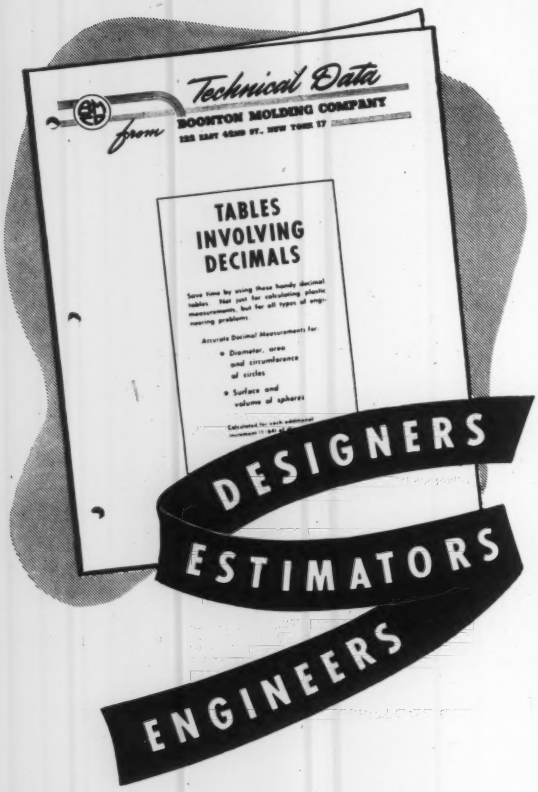


Neoprene gasket, closely fitted at factory to relay terminals, between base and cover, effectively occludes dust.



Plug is standard radio-type plug. Standard finishes are silver lustre lacquer for cover, cadmium for base. Retaining screws hold base securely to panel.

CLARE RELAYS



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By popular request, we have reprinted from our Plastics Handbook, a 4-page folder, containing exceptionally detailed Tables Involving Decimals.

Here's what they contain:

Tables . . .
- by 1/64" increments up to 3"
- by 1/32" increments up to 5"
- by 1/16" increments up to 9"

Equivalent . . .
- Fractions
- Decimals
- Millimeters
- Areas
- Circumference
- Spheres—surface and volumes

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THE BOONTON MOLDING COMPANY

Boonton 3, N. J.

Boonton 8-2020

Boonton

MOLDERS OF MOST PLASTICS BY MOST METHODS

continued under the Cleveland name. Automatic Steel manufactures high-production vertical and horizontal tapping machines, spunsteel pulleys, mercury-actuated clutches, automatic pumps, packs and lifts, and grinding wheels.

♦

Precision Rubber Products Corp. is the new name for **Plastic and Rubber Products Inc.,** Dayton, O., manufacturer of "O" rings. The change was officially effective on June 1.

♦

The **Henry L. Crowley Co.,** West Orange, N. J., and the **Republic Steel Corp.** have opened a jointly owned company and plant in Cleveland, O. to be known as the **Crowley-Republic Corp.** The corporation is now in operation supplementing the West Orange plant production of powdered cores, "Croloy", used in horizontal output transformers, deflection yokes, and other TV components.

♦

Sylvania Electric Products Inc., Montoursville, Pa., has acquired the assets and assumes the obligations of its wholly owned subsidiary, **Wabash Corp.** Sylvania will conduct the business of the Wabash Corp. as the **Photoflash Division of Sylvania Electric Products Inc.**

♦

The **Leonard Ashbach Co.,** parent company of **Garod Radio Corp.,** manufacturer of television and radio under the trade names of Garod and Majestic, has acquired a substantial equity interest in the **Wilcox-Gay Corp.,** manufacturer of television and recording devices. Plans are under way for full production and expansion in the Wilcox-Gay plant, Charlotte, Mich., along with continued full production in Garod's Brooklyn plant.

♦

Manufacturing activities of the **American Magnesium Corp.,** magnesium fabricating subsidiary of **Aluminum Company of America,** were assumed by ALCOA on June 1. The Magnesium corporation became inactive on that date; its Cleveland, O., and Buffalo, N. Y., operations will be continued under ALCOA management.

♦

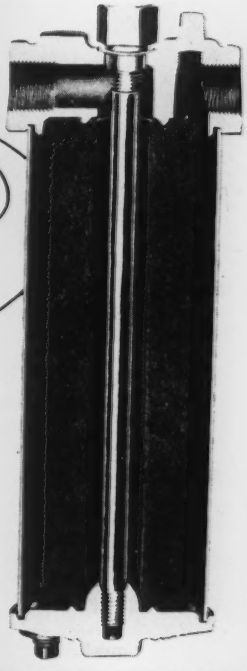
Goodyear Tire & Rubber Co. has begun a one million dollar expansion and improvement program at its St. Marys, O., molded and extruded rubber parts plant. Located directly opposite the present plant buildings bordering on U. S. highway 66, the new addition is to be 170 ft long and 660 ft wide with a floor space of 112,000 sq ft.

♦

A plant improvement program totaling $23,000,000 has been approved by directors of the **Allegheny Ludlum Steel Corp.,** Pittsburgh, Pa. This program is in addition to the $30,000,000 one now in the final stages. The new improvements will more fully integrate Al-

Keeps its Shape..

no matter how much it eats and drinks



Put the Cuno MICRO-KLEAN filter on almost any kind of a diet . . . and it will stay healthy longer than any micronic filter you know of.

Handling a wide range of fluids at a wide range of flow rates . . . the MICRO-KLEAN won't *shrink* or *swell* or *channel*. So there's no place for the fluid to go except where it's supposed to . . . through the cartridge.

Its dirt capacity is *double* that of any comparable filter—so its life is that much *longer*.

Finally, you can install it—inside or outside your equipment—with no trouble at all, because it takes up less space.

Check the box nearby for an explanation of MICRO-KLEAN's exclusive performance.

No Fluid Is Better Than Its Filtration

EXPLANATION

Why won't MICRO-KLEAN *shrink or swell or channel?*
Because the fiber structure is resinous-impregnated and polymerized, and resists any deteriorating effects of most fluids and contaminants.

Why does MICRO-KLEAN *have double dirt capacity?*
Because exclusive "graded density in depth" permits smaller particles to penetrate to varying depths—no surface-loading.

Why does MICRO-KLEAN *take up less space?*
Because the cartridge is *all filter*—no structural elements, no cans, bags, springs, inserts. Full-flow filtration needs much less room.

Also important: pressure drop is low . . . cartridge changing is easy . . . and CUNO MICRO-KLEAN IS GUARANTEED TO REMOVE ALL SOLIDS LARGER THAN SPECIFIED . . . PLUS A LARGE PROPORTION DOWN TO 1 MICRON!

Wide range of applications
Cuno MICRO-KLEAN filters come in varying densities (10, 25, 50 microns) . . . capacities from a few to more than 800 gpm . . . connections from ⅜ in. IPS to 6 in. flanged . . . single or multiple cartridge units.

CUNO

COMPLETE LINE

Fluid Conditioning

Removes More Sizes of Solids from More Types of Fluids

MICRONIC Micro-Klean • DISC-TYPE Auto-Klean
WIRE-WOUND Flo-Klean

Mail this Coupon . . . for FREE Catalogs

Make Sure to Investigate MICRO-KLEAN First

- ☐ Lubricating Oil
- ☐ Hydraulic Oil
- ☐ Water and Water Solutions
- ☐ Compressed Air
- ☐ Fuel Oil
- ☐ Acids

CUNO ENGINEERING CORPORATION
2013 South Vine St., Meriden, Conn.

Please send information on Cuno MICRO-KLEAN for services checked.

Name.....Title.....

Company.....

Address.....

City.....State.....

PLEASE ATTACH COUPON TO YOUR BUSINESS LETTERHEAD

DEPARTMENT OF TECHNOLOGY
BUFFALO PUBLIC LIBRARY

✓ Check

R-B-M INDUSTRIAL CONTACTORS NOW!

Underwriters' Approved. 600 Volts AC

✓ **SIZE**

Non-Reversing

2 to 4 Pole 2-3/4" w. x 3-5/8" h. x 3-5/16" d.
5 to 8 Pole 5-9/16" w. x 3-5/8" h. x 3-5/16" d.

Reversing

2 to 4 Pole 5-9/16" w. x 3-5/8" h. x 3-5/16" d.

Note: 10 and 15 ampere contactors have same mounting and overall dimensions.

✓ **ACCESSIBILITY**

To replace contacts, it is not necessary to disassemble the complete contactor. Just remove the parts comprising the stationary and movable contacts. Contacts can be replaced without disturbing wiring. To change coil, remove magnet frame and coil assembly only. (See illustration below.)

✓ **FLEXIBILITY**

Using a screw driver only, you can easily change any pole from normally open to normally closed. No special parts required. 10 and 15 ampere parts are interchangeable.

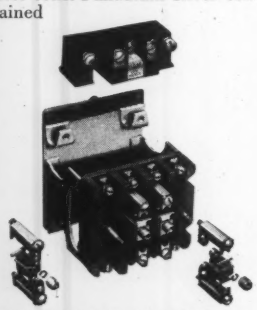
✓ **RELIABILITY**

Laboratory tests involving millions of operations, plus field service of thousands of R-B-M contactors on door operators, radio transmitters, packaging and weighing machinery, hoists, machine tools and many other industrial applications offer proof of dependable, trouble-free performance.

✓ **ADVANCED DESIGN**

Melamine Insulation. Molded coil housing. Ilsco solderless connectors. 50/60 cycle magnet coils. Palladium silver contacts. Stainless steel self-contained contact springs.

Where space is a factor, and accessibility a must—use R-B-M industrial contactors. Initial low cost plus dependable performance will save you money. Write for Bulletin 600 and price list on your company letterhead.



Dept. B-6, R-B-M DIVISION OF ESSEX WIRE CORP.

RBM

R-B-M DIVISION
ESSEX WIRE CORP.
Logansport, Indiana

MANUAL AND MAGNETIC ELECTRIC CONTROLS
—FOR AUTOMOTIVE, INDUSTRIAL, COMMUNICATION AND ELECTRONIC USE

legheny Ludlum's operations and supplement the new electric furnace melting facilities and rolling mills. Manufacturing improvements include a new hot strip mill at the Brackenridge plant and additional cold rolling facilities at the Brackenridge and West Leechburg plants. Erection of a research laboratory near Brackenridge is also provided for.

♦

Synder Tool & Engineering Co., Detroit, Mich., has arranged to have its **Arthur Colton Division** build and market powdered metal presses incorporating the patents, designs and process techniques developed by **Michigan Powdered Metal Products Co.**, Northville, Mich.

♦

The **American Screw Co.**, has moved all administrative, engineering, production, purchasing, sales, and research functions and personnel from Providence, R. I., to a new one-floor plant at Willimantic, Conn.

♦

The **John Waldron Corp.**, New Brunswick, N. J. has acquired the business of the **Meadows Machine Works**, South Kearney, N. J. Both concerns have been engaged in the manufacture of machines used in the converting of paper, textiles and plastics.

♦

The **Townsend Co.**, New Brighton, Pa., manufacturer of solid rivets and other fasteners and small parts, has completed an expansion program which has doubled the capacity and increased the variety of items produced at its Chicago plant, 6600 South Oak Park Ave. Involved in the expansion were the construction of a 12,000-sq ft bay and the installation of a number of cold-heading machines and processing equipment.

♦

Hamilton Pump Co., manufacturer of special machinery, has combined two existing plants under one roof. All production is now concentrated in reconstructed plant quarters located at 39th St. and A.V.R.R., Pittsburgh, Pa.

♦

A short circuit laboratory is in continuous operation at **Arrow-Hart & Hegeman**, Hartford, Conn. While used principally for testing molded case type air circuit breakers, the laboratory is also employed for inductive load tests on motor starters, various types of switches and other A-H & H products. It is also an approved testing station used by Underwriters' Laboratories and serves as an experimental and production testing lab for electrical manufacturers in the area.

♦

Learepeater Corporation of America has acquired the exclusive license to manufacture and sell a new electronic tape device known as the Learepeater. The device was developed and engineerd by the Los Angeles Laboratories of **Lear Inc.**, Grand Rapids, Mich.

XUM

WHERE CAN YOU USE THIS HANDY CUSHION TAPE?

Do squeaks and rattles cause trouble in your product? Are there places where a non-skid surface would make your product easier or safer to use? Do adjacent parts rub or need to be cushioned against possible shock? For a simple solution to production "bugs" like these, use Armstrong's DK-153 Tape.

Armstrong's DK-153 Tape is a resilient, high-friction material made of cork-and-sponged-rubber backed with a pressure-sensitive adhesive. To apply, you simply strip off the protective fabric backing and press DK-153 into place. It will adhere to any clean, dry surface. Normally supplied in rolls, DK-153 Tape is available also in shapes die-cut to your specifications.

The next time you need a simple and inexpensive way to quiet squeaky joints, make slippery surfaces non-skid, or cushion adjacent parts, try Armstrong's DK-153 Tape. For further information and samples, write Armstrong Cork Company, Gaskets and Packings Department, 5106 Arch Street, Lancaster, Pennsylvania. DK-153 Tape is available for export.

IT CUSHIONS PARTS

Strips of DK-153 may be applied quickly and easily wherever needed to cushion glass television tubes from chassis.

IT ELIMINATES SQUEAKS

DK-153, installed between frame and body panels on buses, prevents squeaks and eliminates destructive abrasion.

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Greater efficiency is an advantage which comes to any hard working equipment when Aetna bearings lend a hand. For money saving, problem solving counsel on your next bearing application, submit your prints to Aetna. No obligation, of course!

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An Index of Nomograms

Compiled and edited by Douglas Payne Adams, associate professor of graphics, Massachusetts Institute of Technology; published jointly by The Technology Press of MIT and John Wiley & Sons Inc., New York; 174 pages, 7 by 9½ inches, clothbound; available through MACHINE DESIGN, *$4.00 postpaid.*

An alignment diagram, popularly termed a nomogram which means "law in graphical form", is an invaluable time saver and error reducer for engineers and designers frequently engaged in the repeated solution of mathematical formulas.

This index lists more than 1700 nomograms published in well-known periodicals representing 21 fields of science and engineering. To facilitate its use, the book has been divided into two main parts: Index A is an alphabetical listing of one or two words most frequently associated with each of the diagrams followed by a number referring to Index B which presents the periodical, month, year, volume, number, and page of each nomogram.

Designers generally should find this index of value in that it provides a ready lead to graphs capable of being used for quick, accurate solutions of design problems.

□ □ □

Industrial Inspection Methods
Revised Edition

By Leno C. Michelon, assistant professor of industrial management, Purdue University; published by Harper & Brothers Publishers, New York; 566 pages, 6 by 9 inches, clothbound; available through MACHINE DESIGN, *$6.00 postpaid.*

The designer should be aware of how his design can be inspected to insure economical, efficient production at prescribed quality levels. If the problem of inspection becomes too complex, the production cost and "risk" factors increase. The designer must, therefore, have a sound idea of the methods of inspection. This book provides a source of data necessary for forming a good background related thereto.

The opening section explores the basic concepts of industrial inspection to create a better understanding of purposes and objectives. Basic rules governing clearances, allowances, tolerances, fits, etc., are set forth. Dimensional control, the verification of actual dimensions, is the subject of the second section. In this section are presented the tools, ranging from the common rule to the supermicrometer, employed for

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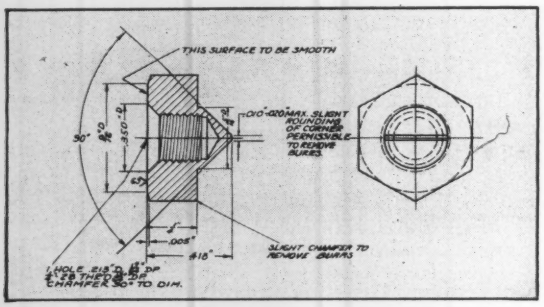

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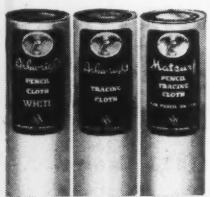

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precision and nonprecision measurement. Primary objective of the discussions is to advise the reader of how and where these tools are used. The section is liberally illustrated with photographs, diagrams, etc., which show construction features of the tools as well as the methods of usage and types of measurements made. To round out the treatment of dimensional control, the author discusses statistical methods of quality control and their place in inspection.

Another aspect of inspection is that which deals with the mechanical properties consisting primarily of strength, machinability, ductility, etc., which describe the behavior of materials in mechanical usage. This section parallels that of dimensional control, presenting the necessary theoretical background coupled with discussions of various destructive and nondestructive inspection methods and machines employed to predict part behavior. Coverage ranges from the Rockwell tester to the magnetic particle and radiography methods.

Manufacturer and Association Publications

Manual on Fatigue Testing: The purpose of this manual is to supply information to those setting up new laboratory facilities, to aid in the proper operation of the equipment and to offer advice on the preparation and presentation of test data. Well-illustrated, the book covers: symbols and nomenclature for fatigue testing—definition of all terms likely to be found in fatigue testing with corresponding symbols; fatigue testing machines—classification of types as to load, stress, and design and operating characteristics; specimens and their preparation—metallic and nonmetallic with detailed polishing instructions; test procedure and technique—planning, selection of machines, selection and preparation of samples, and measurement of specimens; presentation and interpretation of fatigue data—general considerations obtained from three different types of tests designated as material, structural and actual service. An extensive bibliography completes the publication. Copies of this 88-page book may be obtained from the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., at $2.50 each, paperbound; $3.15, clothbound.

Silent Sentinels: This newly revised 236-page book, of particular value to designers engaged in work involving electrical circuits, presents excellently the design and application of protective relays. It is divided into two parts; the first consisting of eleven chapters devoted to applications, the second to eight chapters about the equipment itself.

Part I illustrates graphically the manner in which relays provide protection; contains detailed calculation methods for determining short-circuit currents and voltages; explains the use of vectors for proper relay application; and discusses and diagrams protective relaying of a-c equipment, buss stations, transmission circuits, d-c apparatus, and such special

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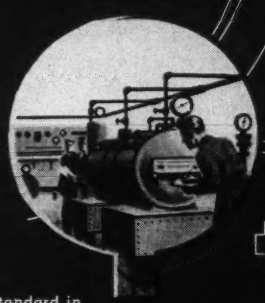
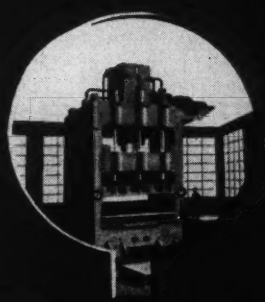


Standard in Testing Laboratories



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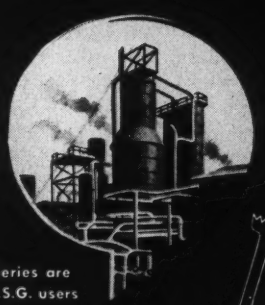

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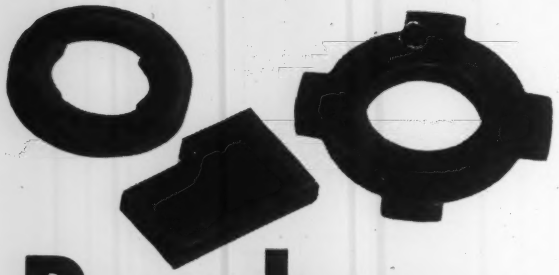

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cases as out-of-synchronism, secondary network protection, etc. Part II presents detailed descriptions of the various types of Westinghouse protective relays. The construction and operation of each type is explained, and its characteristics thoroughly discussed. The entire book is well illustrated with circuit and vector diagrams, photographs and curves. A 21-page appendix includes tables of characteristics of conductors, inductive and capacitive reactance spacing factor values, coil burdens, and a relay application chart.

Copies of the book may be obtained by writing to the Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh, Pa. For quantities under twenty copies, price is $3.00, for twenty or more, $2.70. Price for educational institutions is $3.00 each up to nine copies, and ten or more at $2.00.

A History of Steel Castings: Published under the auspices of District No. 1 of the Steel Founders' Society, this 168-page book covers in novel form the origin, development and personalities of the steel casting industry. Of particular interest to engineers and designers are the sketches of steel casting companies —operations, capacities and key men, past and present. Copies of the book can be obtained by writing to the Steel Founders' Society of America, Philadelphia, Pa. Price per copy, $2.50.

Government Publications

Charts of Thermodynamic Properties of Air and Combustion Products from 300 *to* 3500 *R:* This publication contains an execellent series of nomographic charts that permit the determination of enthalpy change for various processes. The charts cover ranges of temperatures from 300 to 3500 R, hydrogen-carbon ratios from 0.10 to 0.20 and fuel-air ratios from zero to stoichiometric. Derivations of the charts are complete. Methods are presented for the application of chart data to the solution of common thermodynamic problems. Copies of this publication may be obtained by request from the Division of Research Information, NACA, 1724 F St., NW, Washington 25, D. C.

New Standards

Graphical Symbols for Heat-Power Apparatus: Of interest to engineers, designers and draftsmen, this compilation of 44 graphical symbols for heat power apparatus has been approved by the American Standards Association as a new American Standard (Z32. 2.6-1950). It is the sixth of a group of standards developed as revisions and expansions of an existing standard, American Standard Graphical Symbols for Use on Drawings in Mechanical Engineering (Z32.2-1941). Copies of the new standard are available from the American Standards Association, 70 East 45 St., New York 17, N. Y., for $0.35 each.

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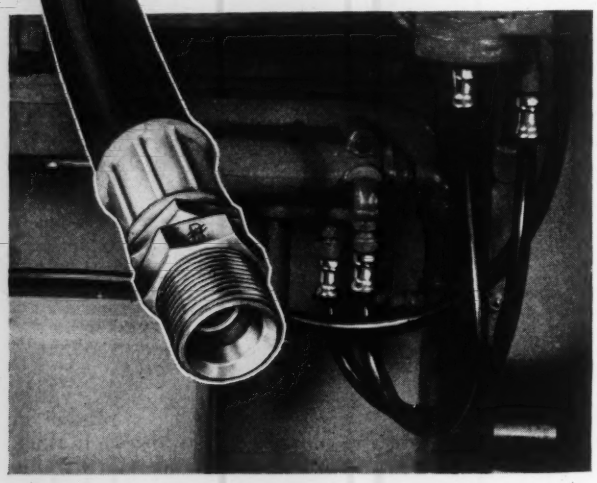

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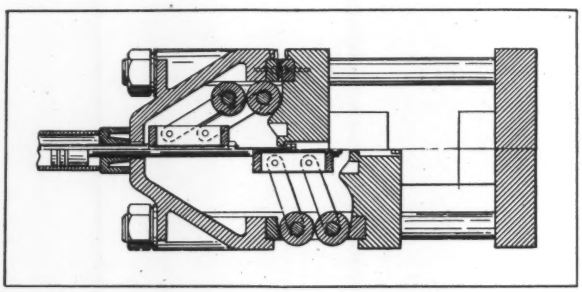
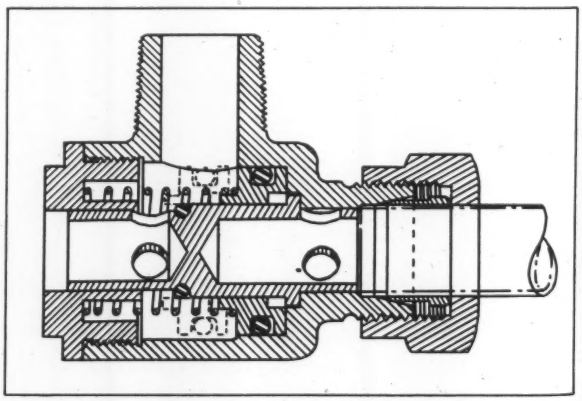
NOTEWORTHY PATENTS

EFFICIENT FORCE MULTIPLICATION in a toggle mechanism is obtained with double rollers operating against cam tracks. Patent 2,496,344, granted to Keith W. Hall and assigned to The Baldwin Locomotive Works, covers such a mechanism utilized on a hydraulic press. Final force multiplication is ob-



tained by the wedging action of two sets of double rollers between inclined planes on the fixed and movable platens. Since the rollers are all of the same diameter, they do not slide but roll on each other and on the inclined surfaces, the wedging action therefore involving no sliding friction. The slant of the inclined surfaces can be designed to give any desired degree of force multiplication.

RAPID VENTING of the fluid in a pressure vessel is accomplished with a simple spring-loaded dumping valve shown in patent 2,488,949. Pressure in the fluid supply line first moves the valve spindle to the left, closing off the pressure container from the exhaust line. When the spindle is seated, a sliding collar on the valve has been carried to the left against spring pressure, opening passage from the pressure



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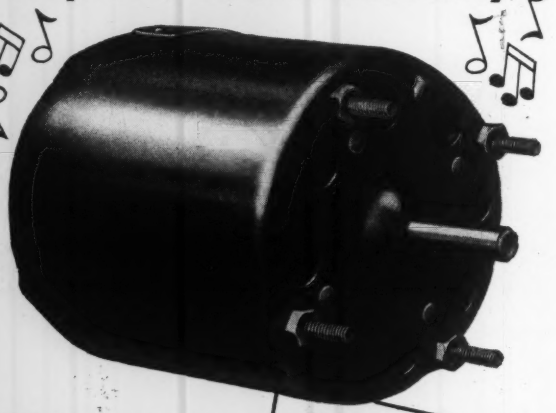

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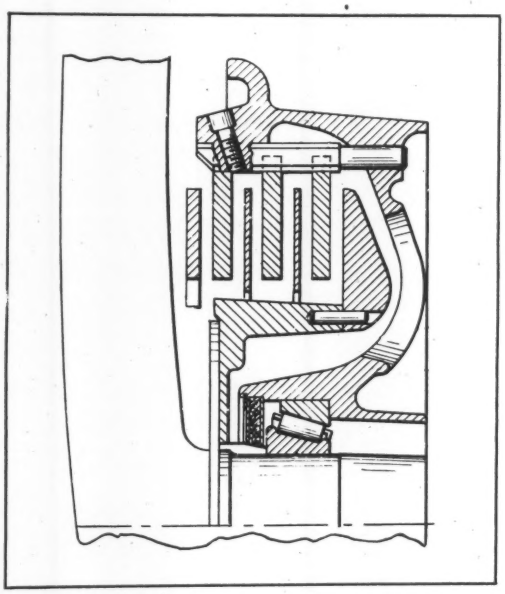
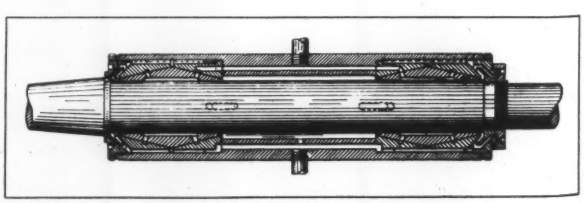
line into the container. Should pressure in the supply line fall, the collar is moved to the right by the spring, carrying the valve spindle and thus opening the exhaust ports to permit flow from the vessel to the exhaust line. Joseph S. Walsh has assigned the patent to The Fawick Airflex Co. Inc.

C-SHAPE DISK BRAKE permitting positioning of aircraft landing wheels close to the strut is covered in patent 2,483,362, assigned to Bendix Aviation Corp. by William H. Du Bois and Irving F. Chapin. C-shaped plunger and cylinder members, extending



around the major part of the wheel, are used to force wheel-mounted disks against lined, stationary disks secured to the strut. Lining material on the stationary disks is discontinued over part of their circumference, allowing air to flow around the rotating members to obtain the required cooling effect. Since the brake is wholly contained within the wheel rim area, this arrangement is well suited to applications with reduced overhang and cramped conditions.

ELIMINATION OF OIL LEAKAGE in a high-speed sleeve bearing design is covered in patent 2,486,227. Oil is introduced at the center of the sleeve and then, through drilled passages, to the underside of double-taper bearing pads attached to the rotating shaft. Oil



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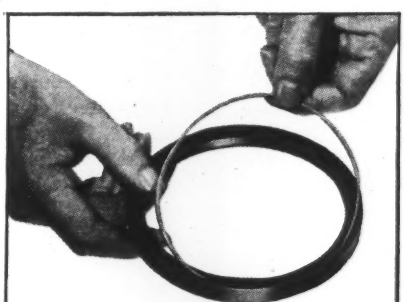

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Clipper Seal's simple design provided important space-saving advantages that helped make this possible. Seals of a narrow flange section were used to permit making the oil seal cavities of minimum depth. Composed of a rigid heel and a flexible lip moulded as a single unit, each seal does an efficient job of retaining oil and excluding dirt, moisture and corrosive fumes—and does this job in a minimum of space.

If you are looking for an oil seal that will help streamline your product, it will pay you to investigate Clipper Seal's many advantages. They are available in various lip designs to provide a choice of bearing surfaces, in sizes to fit shaft diameters from ⅜" up to 66" and for temperatures up to 450 F. Just write Johns-Manville, Box 290, New York 16, N. Y. Ask for brochure PK-46A.

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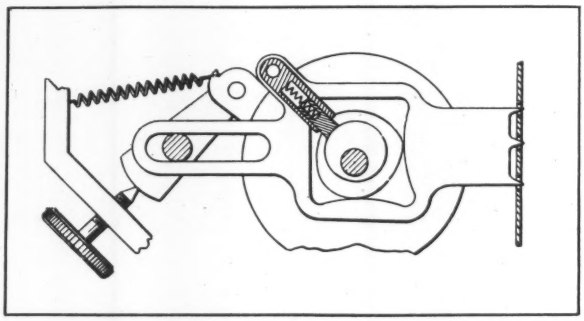
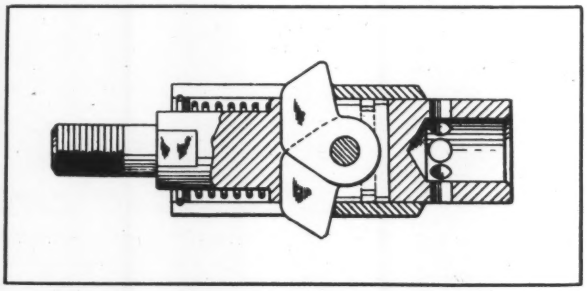
that flows past these taper bearings along the shaft is directed to a drain passage by slingers, one at each end of the bearing sleeve. This design, assigned to General Engineering and Dry Dock Corp. by Clarence W. Tydeman, eliminates seal wear and heat since there is no rubbing contact between rotating and stationary seal parts.

PRECISE ADJUSTMENT of an intermittent claw type film drive mechanism to give a wide range of drive conditions is provided with a spring-loaded complementary cam device. A cam shaped to give the



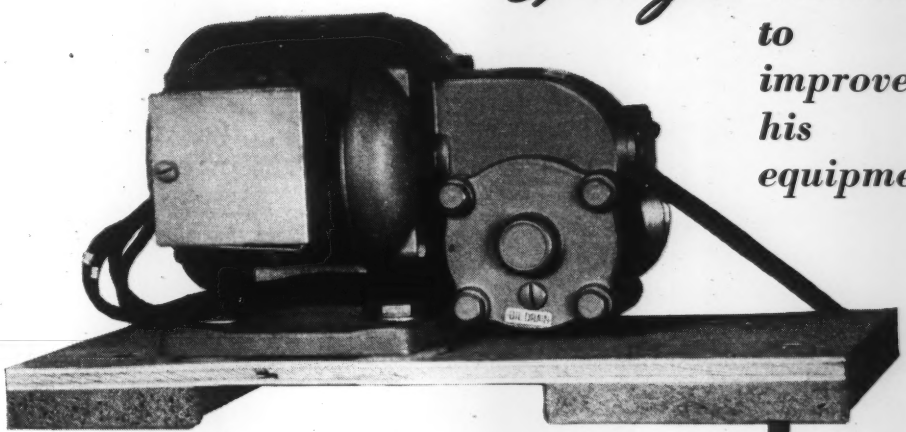
desired claw infeed operates within an opening in the claw member or plate in the device disclosed in patent 2,481,115, granted to Antoine Heurtier. A plunger on the claw plate bears against an eccentric to maintain contact between cam and plate at all times. Pivot point of the claw plate is adjustable toward or away from the center of rotation of the cam to obtain different angular travel of the claws and a consequent difference in the film travel.

HUNTING OF AIR MOTORS, such as those used for hand tools, is minimized with the centrifugal governor design disclosed in patent 2,485,514. A split ring on the valve body supplies frictional resistance to relative movement between the valve and outer sleeve of the governor. Thus, when rapid speed changes tend to throw the flyweights in or out suddenly, with consequent speed fluctuation, this frictional drag acts as a shock absorber in damping out oscillations of the valve. James Sturrock has assigned the patent to The Rotor Tool Co.



an imaginative photographer uses

Spongex® cellular rubber *to improve his equipment*



Portable motor no longer "walks" away from its job

Jack Stock's portable motor "walked" away every time he put it to work. He mounted the motor on Spongex cellular rubber—now it stays on the job. Spongex absorbs the vibrations that give legs to portable motors.

Mr. Stock is in the commercial photography business; he doesn't manufacture motors. As a neighboring businessman in Shelton, he is well acquainted with the properties of Spongex cellular rubber. Now he mounts all his motors, stationary and portable, on Spongex.

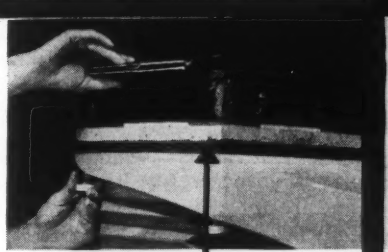
Smaller illustrations show other ways Spongex helps to produce better results in Mr. Stock's business.

If you have a vibration, insulation, cushioning, gasketing, sealing or sound damping problem, think about *Spongex*. Cellular rubber does not become a "product" until you make it one in *your* application.

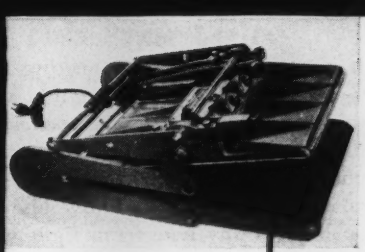
Technical Bulletin on Sponge Rubber available on request.

SRP

Uniform, dustless, printing contact
In place of felt, Mr. Stock substituted Spongex on this photograph printer. Contact on film negative is more uniform, and the tendency of felt to pick up dust is avoided.



Seal against light and dust
In installing this copy camera attachment, custom made by Mr. Stock, on top of a photograph enlarger it was essential to block out dust and light. A Spongex gasket performs perfectly.

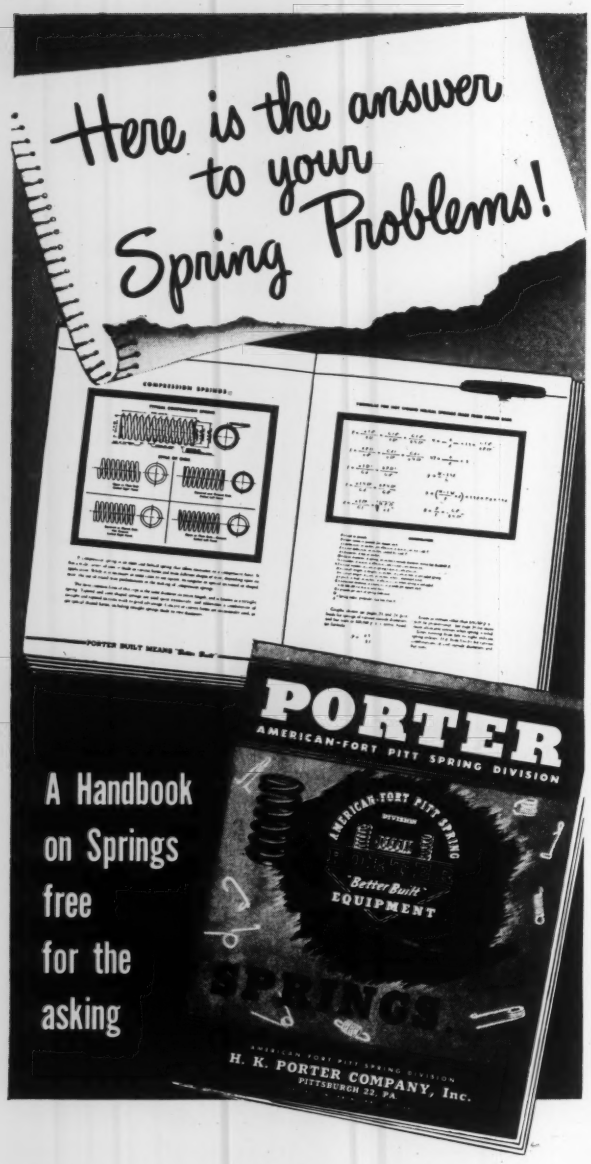


Resilient compression pad
This dry mounting press is fitted with a resilient Spongex cellular rubber base. Spongex equalizes pressure to mount photographs evenly and more securely on their backings.

The World's largest specialists in Cellular Rubber

THE SPONGE RUBBER PRODUCTS COMPANY

300 Derby Place, Shelton, Conn.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A Handbook on Springs free for the asking
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SPRINGS
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AMERICAN-FORT PITT SPRING
Division of H. K. Porter Company, Inc.
2 John St., McKees Rocks, Pennsylvania

Transverse Vibration

(*Continued from Page* 138)

$$\frac{dy}{dt} = \frac{x^3 - (l^2 - b^2)x}{2a^2b}\left(\frac{dy_p}{dt}\right)$$

For an elemental section of the shaft δx in length and distance x from the left support, the kinetic energy is

$$(KE)_{\delta x} = \frac{W_s(\delta x)}{2gl}\left(\frac{dy}{dt}\right)^2 = \frac{W_s(\delta x)}{2gl}\left[\frac{x^3 - (l^2 - b^2)x}{2a^2b}\right]^2\left(\frac{dy_p}{dt}\right)^2$$

Hence the kinetic energy of the section of the shaft to the left of P is

$$(KE)_{0\to a} = \frac{W_s}{2gl}\left(\frac{dy_p}{dt}\right)^2\frac{1}{4a^4b^2} \times \int_0^a [x^6 - 2(l^2 - b^2)x^4 + (l^2 - b^2)^2 x^2]\,dx$$

Integrating and simplifying

$$(KE)_{0\to a} = \frac{W_s}{2g}\left(\frac{dy_p}{dt}\right)^2 R_1 \quad \ldots\ldots (7)$$

where

$$R_1 = \frac{q}{(1-q)^2}\left[\frac{23}{105}q^2 - \frac{8}{15}q + \frac{1}{3}\right] \quad \ldots\ldots (8)$$

and $q = a/l$, so that $a = ql$ and $b = (1-q)l$.

In like manner it may be shown that for the section of the shaft to the right of P,

$$(KE)_{a\to l} = \frac{W_s}{2g}\left(\frac{dy_p}{dt}\right)^2 R_2 \quad \ldots\ldots (9)$$

where

$$R_2 = \frac{1}{q^2(1-q)^4} \times \left[-\frac{23}{105}q^7 + q^6 - \frac{26}{15}q^5 + \frac{4}{3}q^4 - \frac{1}{3}q^3 - \frac{1}{15}q^2 + \frac{2}{105}\right] \quad \ldots\ldots (10)$$

Hence the kinetic energy of the whole shaft, from Equations 7 and 9, is

$$KE = \frac{(R_1 + R_2)W_s}{2g}\left(\frac{dy_p}{dt}\right)^2 \quad \ldots\ldots (11)$$

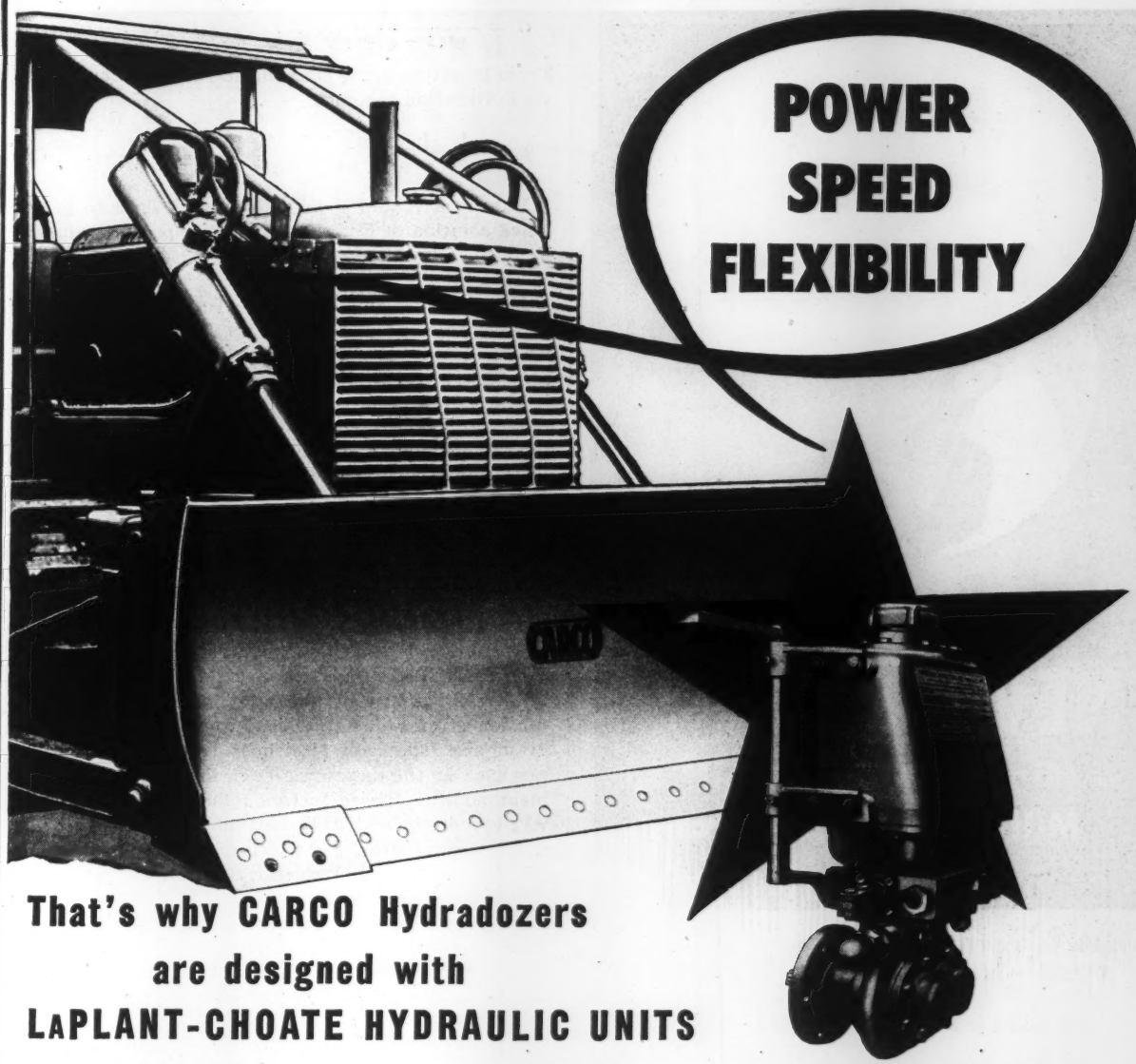
This result means that the whole shaft of weight W_s is dynamically equivalent to a shaft of negligible weight having a concentrated weight of $(R_1+R_2)W_s$ at a distance a from the left support. From Equations 8 and 10

$$R = R_1 + R_2 = \frac{1}{105q^2(1-q)^4} \times [3q^6 - 12q^5 + 14q^4 - 7q^2 + 2] \quad \ldots\ldots (12)$$

From Equation 3 the spring constant is

$$K = \frac{3EIl}{a^2b^2} = \frac{3EI}{l^3q^2(1-q)^2} = \frac{GEI}{l^3} \quad \ldots\ldots (13)$$

where factor G has the value



That's why CARCO Hydradozers are designed with LAPLANT-CHOATE HYDRAULIC UNITS

LAPLANT-CHOATE Hydraulic Units put muscle into the equipment that has to slug it out with hard digging and heavy loads — they supply the speed and flexibility that keeps the job moving economically and profitably. That's why so many manufacturers like Carco use LPC Hydraulic Components — jacks and the all-in-one fluid power control — to provide maximum power, operating smoothness and precision, instant response to controls.

DESIGN YOUR PRODUCT FOR BETTER PERFORMANCE

Full hydraulic operation of your product will give you sales advantages that keep you well ahead of competition— when you specify LaPlant-Choate Hydraulic Units. Proved by more than 25 years use as standard equipment on LPC earthmoving equipment, LPC Hydraulic Units assure you of top flight efficiency and economy.

The Famous Single-Unit LPC Fluid Power Control

Pump, valve and oil reservoir are all combined into a single compact unit. This new "closed system" design completely eliminates long suction lines, reduces the hazard of leaks and assures greatly increased speed and efficiency. In addition, the entire unit is skillfully engineered and precision built for utmost simplicity, easy servicing, and long, trouble-free operation.

Ask for Bulletin B-1152C. LaPlant-Choate Manufacturing Co., Inc., Cedar Rapids, Iowa.

LAPLANT CHOATE

semi-knife-edge bearing reduces frictional wear

This is Ward Leonard's new Bulletin 110 Midget Relay for long, trouble-free service, particularly in equipments subject to vibration.

Exceptionally good vibration characteristics are due to proper proportioning of contact masses and springing combined with heavy pressures on both normally open and normally closed contacts.

Higher contact ratings than most midgets. Available up to 3-pole, double throw. Contact finger leads are insulated with the new, impregnated glass-fiber tubing.

Write for Bulletin 110. Ward Leonard Electric Co., 58 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD ELECTRIC COMPANY
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$$G = \frac{3}{q^2(1-q)^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (14)$$

From Equation 4, the fundamental frequency of transverse vibration becomes

$$f_n = \frac{1}{2\pi}\sqrt{\frac{kg}{W + RW_s}} = \frac{1}{2\pi}\sqrt{\frac{GEIg}{l^3(W + RW_s)}} \quad \ldots (15)$$

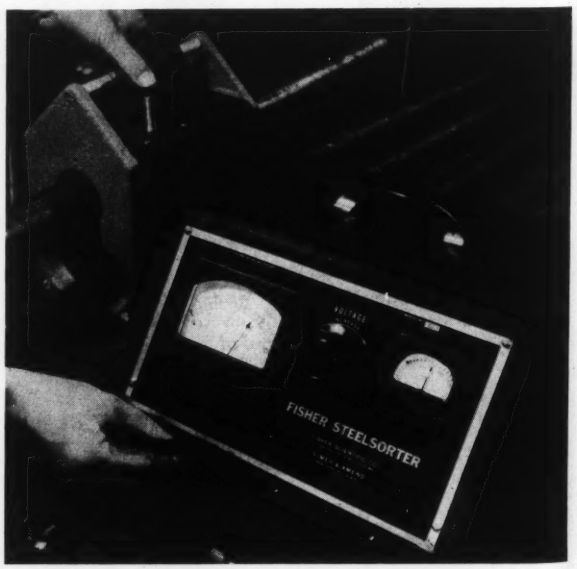
Values of R and G are plotted in *Fig.* 3 to permit quick solution of Equation 15. More precise values of R and G may be determined from Equations 12 and 14 respectively.

It should be noted that the formula for R is of necessity symmetrical about $q = 0.5$. For example, R has the same value for $q = 0.25$ and $q = 0.75$. The same is true for G.

The values of R and G rise rapidly when q is less than 0.1. This region is usually of little engineering importance since the shaft is not likely to be loaded at less than one-tenth from the support. The curves in *Fig.* 3 give values of R and G for values of q between 0.1 and 0.9.

Identifies Different Steels

MAGNETIC properties of steel as affected by the composition of the alloy, the compression or tension strains due to a cold work or rapid quench, grain size, specimen size, heat treatment and aging are used as the measuring stick in the sorting instrument shown. These factors influence the permeability, hysteresis and eddy current losses in steel, and are measurable on the Steelsorter developed by the Jones & Laughlin Research Department and marketed by Fisher Scientific Co. The instrument can sort several hundred mixed semifinished and finished steel parts per hour, the sample acting as a core in a simple transformer. Voltage induced in the secondary coil is used to determine the similarity between two specimens.



PROFESSIONAL VIEWPOINTS

". . . the man with the wrench"

To The Editor:

The article "Bolted Assemblies" by Professors Doughtie and Carter in MACHINE DESIGN, February, 1950, is timely in that it considers tightening-up stresses in the light of recent developments in stress concentration, combined loading, shape of nuts and threads, and gasket design.

About the tightening-up experiments made at Cornell University by John H. Barr in 1902, it may be well to recall the circumstances of the tests. The bolt diameters were ½, ¾, 1, and 1¼ inches, one set with unfinished nuts and washers, another set finished. Twelve experienced mechanics were asked "to select a wrench for each size and then to screw up the nut as in making a *steam-tight* joint." Three tests were made on each bolt by each man. In the tests some of the small size bolts were broken.

In the results of the tests, it was stated that the axial tightening-up load can be approximated as 16,000 times the nominal diameter of the bolt. For design purposes the value 16,000 can be judiciously altered for fastenings not set up as tight as for steam-tight joints.

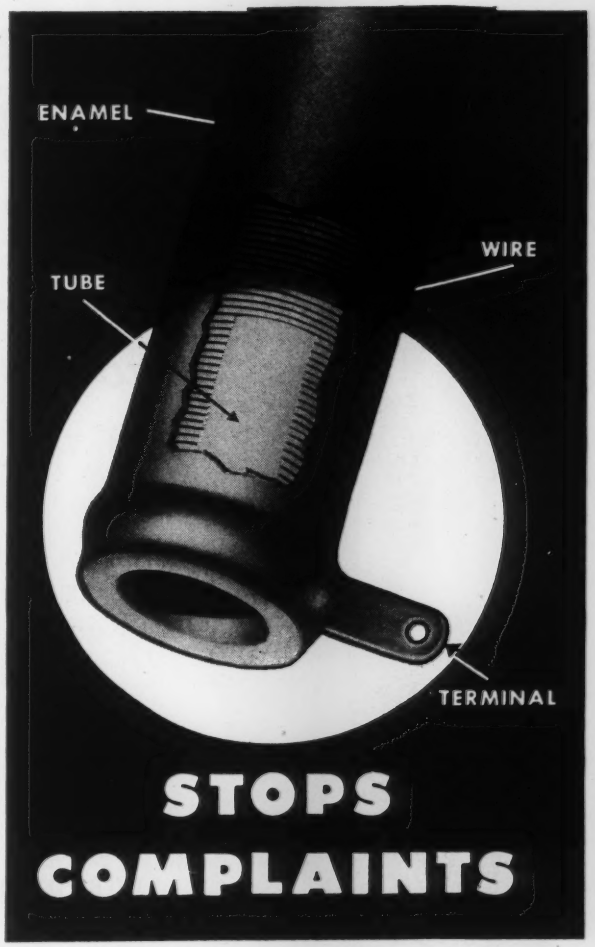
Rational equations for calculating the axial tightening-up load depend on the coefficient of friction between the thread surfaces which, as Professors Doughtie and Carter state, is subject to considerable variation due to lubrication, pressure, and to the condition and fit of the threads. Thus, calculated values of tightening-up loads are questionable and the calculated combined stresses more so due to the uncertainty and inapplicability of available stress-concentration factors to cases of combined stresses.

As has been reported in "Torquing of Nuts in Aircraft Engines," S.A.E. War Engineering Board, 1943, the fatigue durability of a bolt depends on the designer 5 per cent, metallurgist 5 per cent, processing 5 per cent, and the man with the wrench 85 per cent.

—PAUL H. BLACK
Chairman, Dept. of Mech. Engineering
Ohio University
Athens, Ohio

King-Size Packing

Probably the largest one-piece packing ever made, a VIM Leather "U", has been completed to the exact dimensions of 91 inches OD, 89½ inches ID and 1½ inches depth. First built in sections and then assembled, the packing, made by E. F. Houghton & Co., is finished as a single piece. It will be used to clamp friction plates together in an air-operated clutch on a 25-ft high hot forging press, the frame of which will be a single casting weighing 475,000 pounds.



STOPS COMPLAINTS

because exclusive "component-matching" prevents failures

The sure way to avoid trouble due to resistor failure is to use the resistor with the *matched* components.

Ward Leonard alone *makes*—not just assembles—all the components of a resistor. (Wire is drawn to Ward Leonard specifications.) This means that all components are *balanced* in respect to thermal coefficient of expansion and other factors affecting service life. No loosening, no failure—because all parts react the same to their "environment."

Write for bulletin on Vitrohm Resistors, WARD LEONARD ELECTRIC CO., 58 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

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Solves all these Problems

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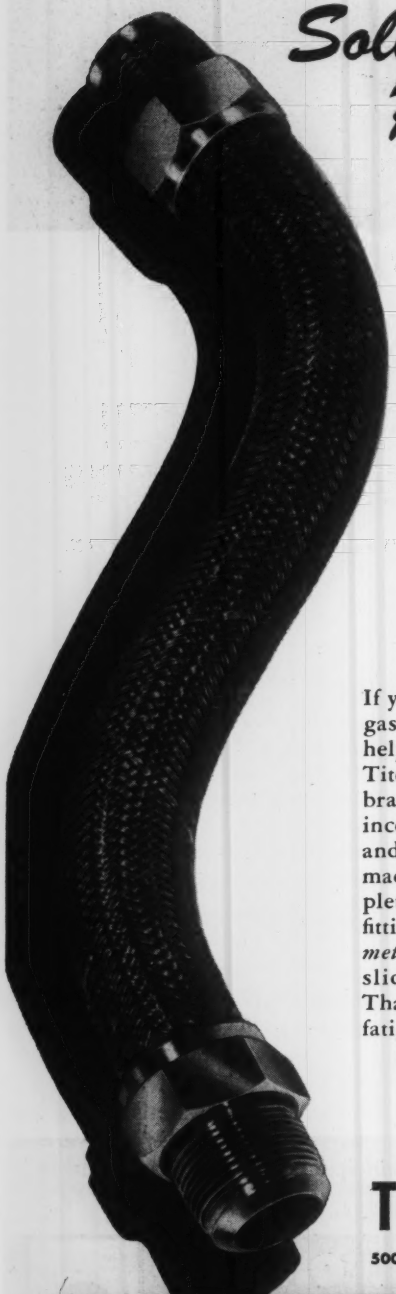

If you use tubing to convey liquids, gases or semi-solids, Titeflex can help you do it better, at less cost. Titeflex flexible tubing is made in brass, bronze, stainless, monel and inconel, to fill most heat, pressure and corrosion requirements. It's made in a full range of sizes, complete with any required types of fittings. In addition, Titeflex is *all-metal,* does not depend on packed sliding joints for its flexibility. That's why it is more resistant to fatigue . . . why it *lasts longer.*

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SALES AND SERVICE PERSONNEL

WITH HEADQUARTERS at the Pittsburgh district office of the Chain Belt Co., 1101 Grant Bldg., Pittsburgh 19, Pa., **Marshall E. Cusic** has been appointed district sales engineer. Mr. Cusic joined Chain Belt Co. in 1937. After serving with the army for several years, he rejoined the company and was assigned to the Rex chain and transmission sales department, where he served as assistant sales manager.

♦

At a recent meeting of the board of directors of Fairbanks, Morse & Co., **O. O. Lewis** was elected to the post of vice president in charge of sales. He has been associated with the company for many years, having served in various sales capacities.

♦

R. D. Moody, manager of Allis-Chalmers' San Francisco district since July, 1947, has been named manager of the Los Angeles district. He succeeds **C. W. Schweers,** who has been appointed manager of the company's New England region with headquarters in Boston. Mr. Moody is succeeded by **James A. Longley Jr.,** who has been a sales representative in the San Francisco office for four years.

♦

The Imperial Brass Mfg. Co., Chicago, has named **C. H. Benson** and **J. T. Greenlee** vice presidents. Mr. Benson is sales manager, distributor sales, and Mr. Greenlee is sales manager, original equipment sales.

♦

Formerly associated with Ledeen Mfg. Co., Los Angeles, Calif., and most recently with Cardwell Mfg. Co., **Alexander Toben** has rejoined Ledeen. He is to take an active part in the sales and application design of Ledeen hydraulic and pneumatic actuating cylinders, as well as other equipment and will also aid in the work of introducing the new medium duty cylinder recently added to the Ledeen line.

♦

Arcos Corp., Philadelphia, manufacturer of stainless low alloy high tensile and nonferrous electrodes, has announced three new appointments to its staff. **Bernard E. David** has

OHIO STOCK GEAR • "off the shelf service"

Gives You faster deliveries lower costs!

You can make a big cut in your power transmission costs with Ohio Stock Gears. On both the machines you manufacture and the equipment you use, you can make substantial savings by replacing special gearing with these nationally known stock gears. Here's why:

1. They are "stock, manufactured in quantities, hence eliminate the extra cost of "specials."
2. No waits, no delivery delays. You can get them right off the shelf of your nearest distributor.
3. Replacement is quicker, costs less and cuts expensive downtime.

Types Available: spur, bevel, miter, helical, worm and worm gear. • Dimetrical Pitches: 24 to 3

Check your gear needs with the nearest distributor listed here and see for yourself the savings you can make on your own requirements.

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Memphis Bearing & Supply Co.
*Miami 9, Fla.
General Equipment & Supply, Inc.
*Minneapolis, Minn.
Industrial Supply Co.
*Muskegon, Mich.
Lake Shore Machinery & Supply Co.
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(Reducers) Woodward Wight & Co.
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(Reducers) Patron Transmission Co.,
(Gears) Atlantic Gear Works
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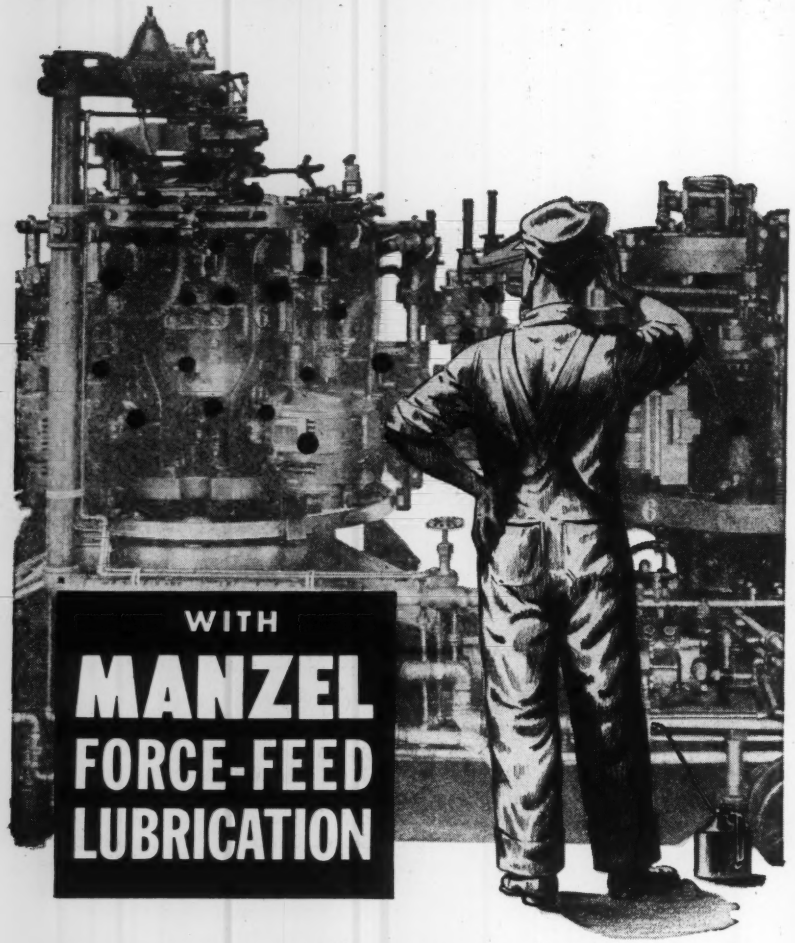

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MANY spots requiring many different amounts of lubricant make it easy for a new man (or even an experienced one) to get all mixed up.

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joined the company as a special field engineer, located in Los Angeles; **Walter Gordon List** will act as special field engineer in the Ohio-western Pennsylvania territory, assisting Williams & Co. Inc., Pittsburgh; and **J. J. Schlass,** newly appointed sales representative, will work in the Philadelphia district.

♦

At a recent meeting of the board of directors of Link-Belt Co., **David E. Davidson** was elected vice president for sales, with headquarters at the executive offices, 307 North Michigan Ave., Chicago 1, Ill. He has been general manager at the company's Pershing Road plant, Chicago, since 1947 and is succeeded in this position by **Eugene P. Berg,** former assistant general manager.

♦

Vice president in charge of sales of SKF Industries Inc., **Richard H. DeMott** has been elected president of the Sales Managers' Association of Philadelphia. He will take office next October.

♦

Howard M. Boyd has been appointed sales manager for the parts division of Sylvania Electric Products Inc. and will direct sales of a wide range of fine solid, clad and plated wires, precision small parts, fine metal ribbon products and radio tube sockets and specialized subassemblies.

♦

Two appointments have recently been announced in the aluminum division of the Reynolds Metals Co. **F. F. Tiffany,** formerly district manager of the company's Dayton, O., office, has assumed the duties of division manager in the Pittsburgh area, with headquarters in the company's Pittsburgh field office, and **T. D. Lewis,** who served for some time as sales representative in the San Francisco area, is now division manager in the Atlanta office.

♦

J. P. Murphy has been transferred from the Dow Chemical Co.'s magnesium technical service and development group to the magnesium sales staff of the company's Chicago sales office.

♦

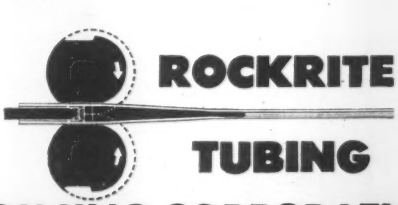
New manager of sales of the General Electric Co. specialty transformer and ballast divisions at Fort Wayne, Ind. is **C. E. Burke.** He has served in a number of engineering and sales assignments both in the

Twice as fast
FROM ROCKRITE TUBING

You can often *double* output and cut machining costs *in half* by using close-tolerance Rockrite Tubing for cylindrical and ring-shaped parts. Take ball-bearing raceways, produced from 52100 analysis tubing, for example . . .

They are now being turned out twice as fast from Rockrite Tubing as from ordinary tubing. Quick reaming replaces slow boring. Outside finishing is faster because Rockrite Tubing is sized to much closer tolerances than tubing sized by other methods. Additional stations can frequently be released so that two parts can be machined at once with a double cut-off. Tool costs go down.

DO YOU KNOW the 3 requirements essential for tube accuracy? Read about them in new bulletin being prepared that tells how and why close-tolerance Rockrite Tubing can save you money.



Rockrite Saves More Than Any Other Tubing

- Higher cutting speeds
- Tools last longer between grinds
- Work-surface finishes are better
- Stations on automatics are often released for additional operations
- Extra-long pieces available—less down-time for magazine stocking and fewer scrap ends
- Closer tolerances often eliminate necessity for machining on outside or inside

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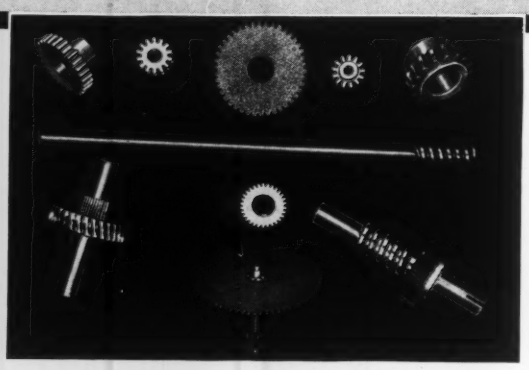

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New Bulletin MD-6 now available upon request.

Rynel Corporation
STERLING, ILLINOIS

company's district sales organization and in the general office. Just prior to his present appointment Mr. Burke held the position of manager of the distribution transformer sales division for the transformer and allied product divisions.

♦

Walther H. Feldmann, who resigned as president of the Worthington Pump and Machinery Corp.'s subsidiary company, Electric Machinery Mfg. Co. of Minneapolis, has been named vice president in charge of sales for Worthington. He will make his headquarters at the Worthington executive offices in Harrison, N. J.

♦

Associated with the Republic Rubber Division of Lee Rubber & Tire Corp., Youngstown, O., since 1923, **Howard H. Sprinkle** was recently appointed assistant sales manager of the division.

♦

At the annual meeting of stockholders of Handy & Harman, **Judson C. Travis** was elected to the office of executive vice president and will be responsible for the sales, manufacturing, refining and research operations of the company and will have general charge of its five plants. At the same time **John W. Colgan** was also elected vice president, in which capacity he will function as sales manager.

♦

The Riverside Metal Co. of Riverside, N. J., has appointed **George W. Spanberg** manager of its Chicago sales office at 549 West Washington Blvd. and at the same time named **James T. Duffy III** as assistant in the Chicago office.

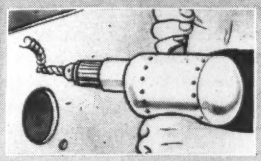
♦

L. C. Newton, 1931 University Ave., St. Paul 4, Minn., has been appointed sales engineering representative for aluminum bronze and silicon bronze vacuum die castings for the Aurora Metal Co., Aurora, Ill. Territory includes the state of Minnesota and northern Wisconsin.

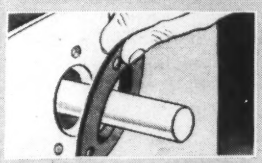
♦

The Radio Corp. of America announced recently that it has resumed merchandising and sales of its line of industrial electronic equipment, thereby terminating distribution arrangements with the Allis-Chalmers Mfg. Co. **A. H. Hofberg** has been made manager of radio frequency heating products to head RCA sales and merchandising activities for both dielectric and induction heating equipment, and the Eriez Mfg. Co. of Erie,

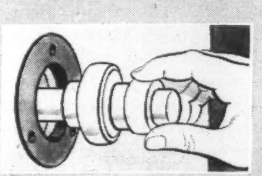
EASY TO INSTALL
NO COSTLY MACHINING



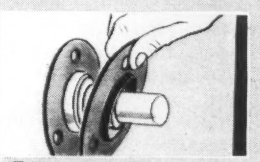
1 Provide holes in machine frame to accommodate flange cup and flange mounting bolts.



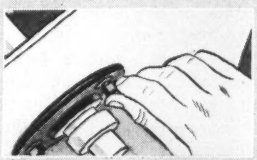
2 Slip one half of flange, with cup side facing assembler, over shaft.



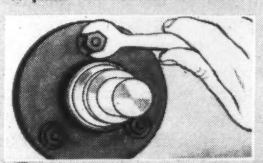
3 Slide bearing and collar on shaft.



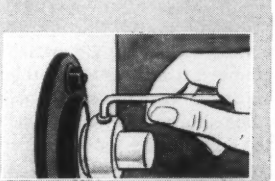
4 Slip other flange over shaft with cup side toward bearing.



5 Line up bolt holes of flanges with bolt holes on machine, slide bearing into proper position and bolt unit in place. DO NOT TIGHTEN BOLTS.



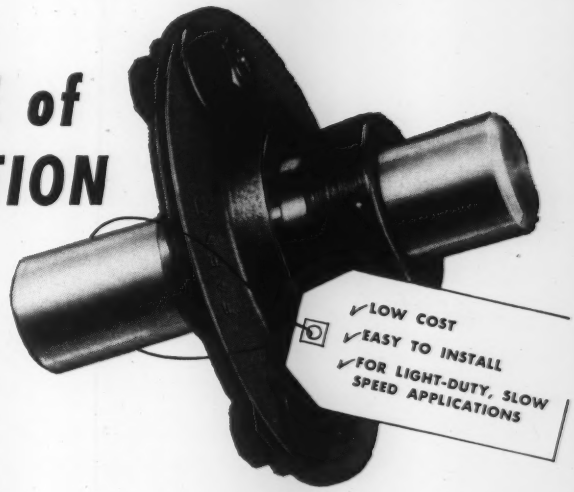
6 Repeat for other end of shaft and then tighten bolts on both ends.



7 Engage locking collar by turning in direction of shaft rotation until cam in collar drops over cam on inner ring. Continue turning until cams lock. Tighten set screw.

Now you can equip your machines with ball bearings at *NEW LOW COST*

. . . with *NEW EASE of INSTALLATION*



The Fafnir Flangette

incorporating the famous Fafnir Wide Inner Ring Ball Bearing with Self-Locking Collar

Now you can add ball bearing performance, power economy and longer bearing life to your equipment within your cost limits. A brand new, simple, low cost housing idea eliminates costly machining, makes maintenance easier. A pair of pressed steel flanges which can be bolted anywhere on your machine, provides a lightweight, compact, sturdy housing for a standard Fafnir Wide Inner Ring Ball Bearing. Curved contour of inside surface of flanges matches curving contour of bearing outer ring to provide full self-alignment when installing the unit. A twist of the collar locks bearing to shaft. Sealed both sides with Fafnir Mechani-Seals . . . a labyrinth design of interlocking steel plates. Write today for illustrated folder. The Fafnir Bearing Company, New Britain, Conn.

FAFNIR
BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

The ABC of MST

A ALWAYS MAKES POSSIBLE
B BETTER PRODUCTS AT
C LOWER COST

Michigan
The Modern Electric Resistance

WELDED STEEL TUBING

A Quality Product

Standard Sizes

Tube Diameter O.D. Size	Maximum Wall BWG Decimal	Gauge	Minimum Wall BWG Decimal	Gauge
1/4	.049	18	.028	22
3/8	.065	16	.022	24
1/2	.083	14	.022	24
5/8	.095	13	.022	24
3/4	.095	13	.022	24
7/8	.095	13	.028	22
1	.095	13	.028	22
1 1/8	.095	13	.028	22
1 1/4	.095	13	.028	22
1 3/8	.095	11	.035	20
1 1/2	.120	11	.035	20
1 5/8	.120	11	.035	20
1 3/4	.120	9	.035	20
1 7/8	.148	9	.035	20
2	.148	9	.035	20
2 1/8	.148	11	.035	20
2 1/4	.120	9	.035	20
2 3/8	.148	11	.035	18
2 1/2	.120	9	.049	18
2 5/8	.148	9	.049	18
2 3/4	.148	9	.049	18
2 7/8	.148	9	.049	18
3	.148	9	.049	18
3 1/8	.148	9	.049	16
3 1/4	.148	9	.065	16
3 3/8	.148	9	.065	16
3 1/2	.148	9	.065	16
3 5/8	.148	9	.065	16
3 3/4	.148	9		
3 7/8	.148	9		
4	.148			

Can be Bent ... FLANGED, EXPANDED, TAPERED, DEPRESS BEADED, EXPAND BEADED, ROLLED, EXTERNAL UPSET, INTERNAL UPSET, FLUTED, SPUN CLOSED, FORGED, BEVEL FLANGED, FLATTENED, SWAGED

ROUND

1/4" to 4" O. D. 9 to 22 gauge

SQUARE-RECTANGULAR

1/2" to 2" 20 gauge 1" to 2 3/4", 14, 16, 18 gauge

Consult us for engineering and technical help in the selection of tubing best suited to your needs.

RESISTANCE WELDED STEEL TUBING

Michigan STEEL TUBE PRODUCTS CO.

THE OLDEST NAME IN ELECTRIC

33 Years in the Business

9450 BUFFALO STREET • DETROIT 12, MICHIGAN

FACTORIES: DETROIT, MICHIGAN • SHELBY, OHIO

DISTRIBUTORS: Steel Sales Corp., Detroit, Chicago, St. Louis, Milwaukee, Indianapolis and Minneapolis—Miller Steel Co., Inc., Hillside, N. J.—C. L. Hyland, Dayton, Ohio—Dirks & Company, Portland, Oregon—James J. Shannon, Milton, Mass.—Service Steel Co., Los Angeles, Calif.—American Tubular & Steel Products Co., Pittsburgh, Pa.—Strong, Carlisle & Hammond Co., Cleveland, Ohio

Pa. is new distributor for RCA's line of electronic metal detectors. Mr. Hofberg, a veteran development and commercial engineer of both the Victor Talking Machine Co. and RCA Victor, will be assisted in his new duties by **George B. Russell,** former sales engineer of the Allis-Chalmers Co.

♦

Allied Control Co. Inc. has announced the appointment of **O. I. Price** of Magnetic Devices Inc., Frederick, Md., to handle sales of their electrical relays in the states of Maryland and Virginia and the District of Columbia.

♦

E. G. Schroeder was recently appointed sales manager of the Electric Products Co., Cleveland. He will be responsible to **G. J. Berry,** vice president in charge of sales, for all headquarters and field direct sales activities. Previously associated with the company as field sales manager, and prior to that, district manager of the Detroit office, Mr. Schroeder has a broad industrial sales background.

♦

Formerly in charge of midwestern Aer-a-sol sales for the company, **Walter E. Anderson** has been promoted to sales manager of Aer-a-sol products by the Bridgeport Brass Co., Bridgeport, Conn.

♦

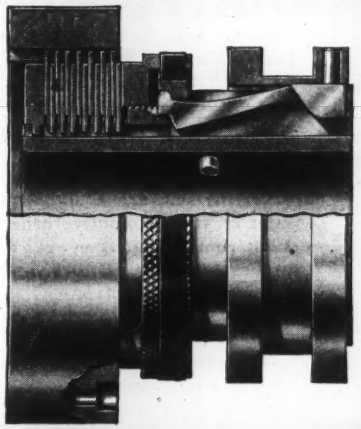
W. F. Boyer Sr., veteran of many years' standing in the aluminum foil industry, has been named sales manager, foil division, for Kaiser Aluminum & Chemical Sales Inc. Mr. Boyer will make his headquarters in the company's new general sales office in Chicago.

♦

Appointment of **John P. Sheridan** as Washington engineering representative of the Sprague Electric Co., North Adams, Mass., has been announced. Mr. Sheridan comes to Sprague from the Office of Naval Research, where he was a civilian staff consultant on electronic equipment.

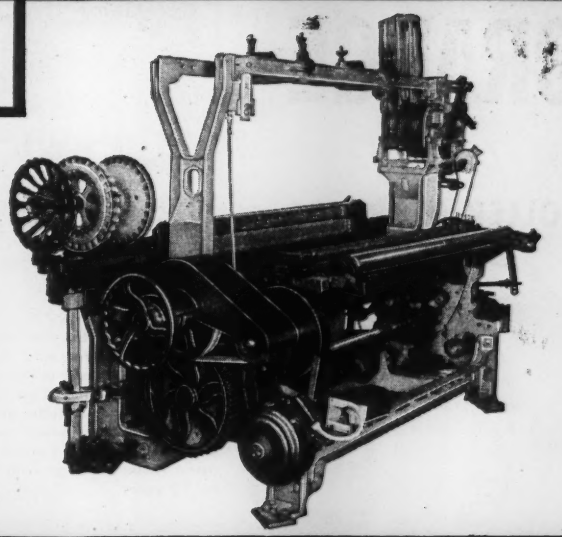
♦

Timken Roller Bearing Co. officials have announced that **J. R. Comber,** former manager of the sales order division, has been named to head the Canton, O. office of the automotive division and, in addition, will handle special sales administration assignments. At the same time, **E. H. Hughes** was appointed manager of the sales order division. Mr. Comber joined the company in 1913. Five



MAXITORQ

Keeps Good Company ... in the TEXTILE FIELD



The Maxitorq floating disc Clutch is now playing a new part in aiding Textile plants to cut production costs. Introduced by the H. F. Livermore Corporation, manufacturers of improved loom parts and accessories, a "package drive" unit is available for attachment to existing looms. The unit consists of two Maxitorq Clutches, one used as a drive, the other as a brake. Single units of either are also supplied. Thus the machine may be individually driven at today's high speeds . . . for greater output.

The compact, streamlined Maxitorq is original equipment with leading manufacturers of Machine Tools, Machines for Packaging, Mining, Labeling, Lumbering . . . for Trucks, Hoists, Sweepers, Mowers, etc. Its design is of utmost simplicity yet highly efficient within its capacity to 15 H.P. @ 100 r.p.m. "Floating discs" prevent drag, abrasion and heating. Clutches are shipped ready to slip onto a shaft, yet adjustment, take-apart and assembly are manual. Special Driving Cups, if desired, also Overload Release Feature.

Send for NEW 1950 Catalog MD6

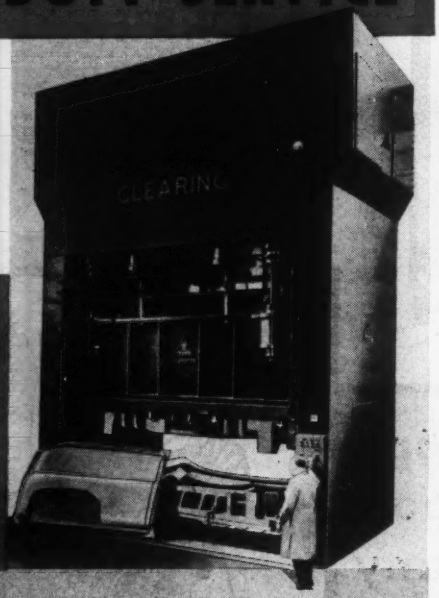
4CJ50

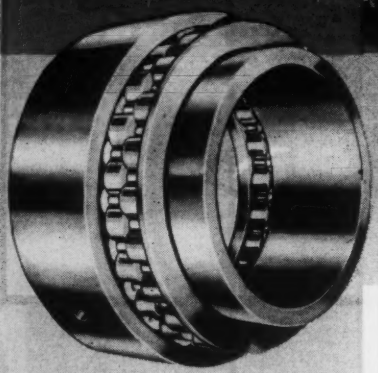
THE CARLYLE JOHNSON MACHINE COMPANY
MANCHESTER • CONNECTICUT

For HEAVY DUTY SERVICE

Drive Shafts of CLEARING PRESSES rotate on

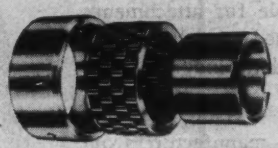
ORANGE "STAGGERED" ROLLER BEARINGS





Clearing Hydraulic and Mechanical Presses exert accurate pressures up to thousands of tons—turn out huge sections of car bodies in a single stamping. Clearing engineers find Orange Staggered Roller Bearings best suited to withstand the severe service in the drive shafts of Clearing Presses and have been using these bearings with excellent success for 10 years.

How unique staggered and meshed roller design provides greater load carrying capacity



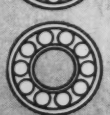


Illustration above shows how load is divided over many short rolls instead of a few full length rolls. At left, end views of Staggered bearing and conventional bearing show how staggered roller design brings a multiplicity of contact points within the loaded zone.

DO THE WORK OF LARGER-SIZE CONVENTIONAL BEARINGS

Wherever designs call for bearings combining extreme ruggedness, high load carrying capacity and precision running—be sure to study the capacities of Orange Staggered Roller Bearings. Size for size, they carry higher loads than conventional roller bearings. Used in new designs, you can carry the required load with smaller size Staggered bearings and save space. Used as changeovers in present equipment, you gain extra load capacity and longer service life.

Orange Staggered Roller Bearings are available in a full range of interchangeable sizes—in the 200 and 300 series, from 305 to SW-244, and in the 5200 and 5300 series, from 5306 to 5334. Also with notched-type inner race, supplied with separable outer and inner races, as required. Special sizes to order.

WRITE FOR ENGINEERING DATA FOLDER
showing construction, types, sizes, capacities, installation data, etc.

ORANGE

ORANGE ROLLER BEARING CO., INC.
556 Main Street, Orange, N.J.

years later he was placed in charge of the sales order division, the position he has held up to this recent promotion. Mr. Hughes came to Timken in 1938, starting in the general accounting department. For the past several years he has been manager of the systems department. Associated with Mr. Hughes in the sales order division are **T. J. Wayne,** manager of the automotive orders; **H. P. Dickerhoff,** manager of industrial orders; and **J. L. Brown,** manager of bearing order control.

♦

J. M. Hoskinson, who has had broad engineering experience in the machine tool engineering field, has been made sales engineer of the Geo. D. Roper Corp. pump division.

♦

Formerly chief engineer of the Eriez Mfg. Co., Erie, Pa., **Wallace W. Mojden** is now associated as sales engineer with Mills-Winfield Co. of Chicago, distributors of Eriez permanent nonelectric magnetic separators.

♦

Appointment of **J. A. Herring** as technical sales representative for Marvinol vinyl resins in the New York area was announced recently by Naugatuck chemical division of United States Rubber Co. Mr. Herring, who for the past nine years has worked closely on the development, production and sales of Naugatuck's new plastic materials such as Vibrin polyester resins, Kralastic molding powders, PQL resin enamels and Kotol strippable coatings, will make his headquarters at the Naugatuck chemical New York office at 254 Fourth Ave.

♦

James C. Smith has been appointed industrial sales manager of Potter & Brumfield, relay manufacturers of Princeton, Ind. Mr. Smith was formerly sales manager of Phillips Control Corp.

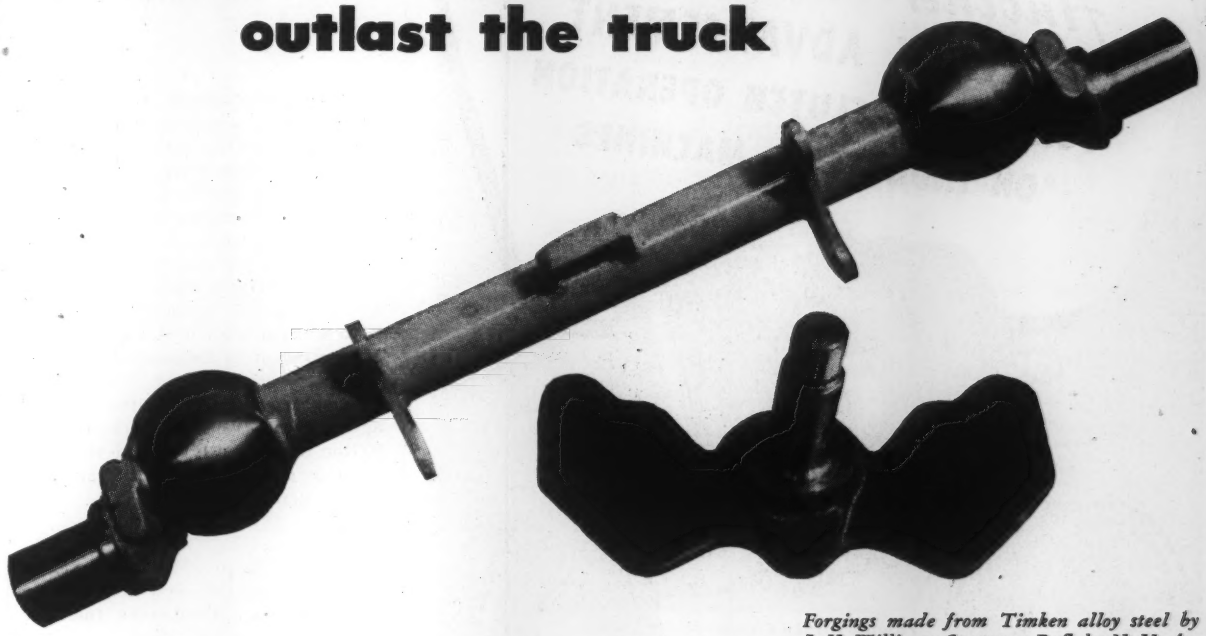
♦

Previously in the main office and plant of the Selas Corp. of America, Philadelphia, **Anthony J. Potts** has been appointed Chicago district manager for the company. The Chicago office is located at 3857 West Washington Blvd.

♦

The Sessions Clock Co. has announced the appointment of **Charles L. Allen** as sales manager of the company's timer division. He will be responsible for the promotion and sales of the newly developed line of Sessions operated switch timers.

Forgings made of TIMKEN® steel help Truxmore 3rd axle outlast the truck



Forgings made from Timken alloy steel by J. H. Williams Company, Buffalo, N. Y., for Truck Equipment Company, Buffalo, N. Y.

ONE reason why Truxmore 3rd Axle assemblies can outlast as many as five different chassis is the forgings shown above.

These two vital parts of the assembly have to carry extremely heavy loads in high speed, heavy duty transportation service. Yet they have lasted for hundreds of thousands of miles in actual operation. A big share of the credit goes to the steel they're made from—Timken® forging bars.

Each analysis of Timken forging bars has uniform forgeability, uniform chemical and physical properties, and uniform response to heat treatment—from bar to bar and from heat to heat. Surface and internal quality are uniformly superior. This uniformity is assured by The Timken Roller Bearing Company's complete, rigid quality control—from melt shop through final inspection.

As a result, the finished forgings have uniform, high quality. And they can be made at lower cost—through fewer delays, rejects and changes in shop practice.

Find out how Timken forging bars can help you make better forgings at less cost. Consult our Technical Staff. Also write for our free, authoritative booklet, "Evaluating the Forgeability of Steels". The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing.

Another
FAWICK ADVANCEMENT
FOR BETTER CLUTCH OPERATION
ON INDUSTRIAL MACHINES
Fawick Airflex Clutch and Brake Conversion Assembly for 1½" Forging Machine
Fawick CB Element with Air-agitating Ventilating Adapter
The New Fawick Air-agitating Ventilating Drum

THE IMPROVED FAWICK PACKAGE-UNIT CONVERSION

Another Fawick advancement in clutch design is now ready for use on industrial machines. The simple rugged construction of Fawick elements, with their proven performance, remains the same; the new design provides cooler operation under heavy-duty, fast-cycle use, and in compact installations.

The new Fawick friction drum incorporates vents plus internal and external cooling fins for faster heat dissipation. The new FAWICK clutch-cooling adapter provides forced-air cooling to all clutch parts.

Full information on Fawick clutches and brakes may be obtained by writing to the Home Office, Cleveland, Ohio.

All desirable clutch characteristics are built into Fawick Airflex units

Airflex

FAWICK CLUTCHES = AXIAL CONTACT + 360° RADIAL CONTACT + SHOCK ABSORPTION + CONTROLLED TORQUE = PEAK EFFICIENCY

SALES NOTES

THE SOUTHERN PORTION of the sales territory served by the St. Louis electrical division branch of **Wagner Electric Corp.** was recently set up as a separate unit with headquarters in Memphis and a sales office in New Orleans. A. C. Allen will remain at Memphis as branch manager of the newly established territory, and the remaining territory, with a main branch in St. Louis and a sub-branch in Indianapolis, will be under the direction of J. J. Scheid, who succeeds H. N. Felton as manager of the St. Louis branch. Mr. Felton was recently elected vice president in charge of sales of the Wagner company.

♦

In order to provide better service to customers, the New York offices of **Raybestos - Manhattan Inc.** have been moved to 500 Fifth Ave., New York City. These offices include the New York and New England district office of the Manhattan rubber division and the corporation export department including **Allied Asbestos and Rubber Co. (Export) Inc.**

♦

Newly appointed representative for the **Chiksan Co.** in the state of Arizona is **George S. Thomson Co.,** 915 South Central Ave., Phoenix, Ariz.

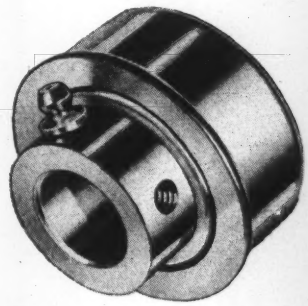
♦

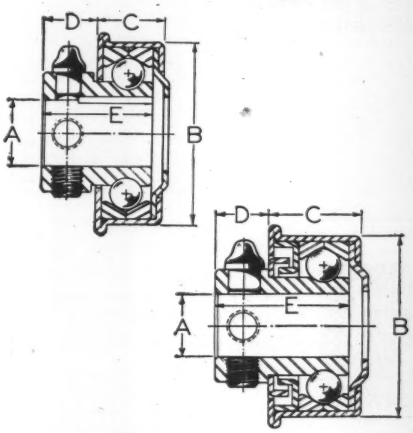
Three new offices have been opened by **Arthur B. Sonneborn Co.** of 631 Fisher Bldg., Detroit 2, Mich., representing **National Electric Welding Machines Co.,** Bay City, Mich. for the state of Michigan and northwestern Ohio. One office is at 303 Paterson Bldg., Flint 3, Mich., another at 1322 Grand Rapids National Bank Bldg., Grand Rapids 2, Mich., and the third in Room 206, 1118 Madison Ave., Toledo 2, O.

♦

The appointment of **Associated Air Service** of Dallas, Tex. to represent the precision gear division of **Foote Bros. Gear and Machine Corp.** in the sales and service of aircraft quality gears, actuators and power units in the states of Kansas, Oklahoma, Texas, Missouri and Arkansas was announced recently. Located at 234 Terminal Bldg., Love Field, Dallas,

"Commercial" Ball Bearing Data...#3 of a Series





TYPE "A" UNGROUND FLANGED BALL BEARINGS WITH SET SCREWS, UU SEAL AND ALEMITE FITTING

APPLICATIONS: Replaces expensive precision bearings when load and speed conditions permit; saves costly machining and assembly time required by bushings and plain sleeve bearings.

Wherever dirt or other foreign matter is a problem—in agricultural and wood working machinery, conveyors.

FEATURES: UU SEAL retains lubricant and prevents dirt from entering vital bearing parts.

FLANGED OUTER RING eliminates costly counterboring when locating bearing.

EXTENDED INNER RING WITH SET SCREWS permits securing at any point on a plain shaft.

CLOSE TOLERANCES held to ±.002" on both bore and O. D.

Bearing No.	Bore A ±.002"	O.D. B ±.002"	Width O.R. C	Width I.R. E	Ext. D	Type Seal	Balls No.	Balls Size	Rating at 600 RPM
CS 2902	5/8	1 5/8	1 7/32	1 1/8	5/8	Lab-Plate	13	1/4	135
CS 2548X1	1/2	1 3/4	2 5/32	1 21/64	5/8	Lab-Plate	12	9/32	160
CS 2970X1	5/8	1 3/4	2 5/32	1 21/64	5/8	Lab-Plate	14	1/4	145
CS 2035X1	3/4	1 3/4	2 5/32	1 21/64	5/8	Lab-Plate	14	1/4	145
CS 1802X4	3/4	1 7/8	1 7/32	1 5/64	5/8	Plate	16	1/4	165
CS 1062X2	3/4	1 13/16	7/8	1 25/64	5/8	Lab-Plate	12	5/16	195
CS 2246X1	1	2 1/4	7/8	1 1/2	5/8	Lab-Plate	15	5/16	240
CS 2691	1 1/4	2 1/4	2 7/32	1 3/8	5/8	Lab-Plate	15	5/16	240
CS 2587X1	1 1/4	2 17/32	2 1/32	1 1/4	5/8	Plate	18	5/16	290
CS 1987X2	1 1/8	2 5/8	1 3/4	1 3/8	5/8	Lab-Plate	18	5/16	290

WRITE FOR OUR NEW CATALOG NO. 11.

In its 40 pages you'll find dimension data and load rating tables for the complete "Commercial" Bearing line as well as information on Schatz Special Bearing Engineering Service, which has helped many manufacturers solve unusual bearing problems by adapting or designing a low-cost bearing especially suited to individual needs.

The Schatz Manufacturing Company
6760 FAIRVIEW AVENUE, POUGHKEEPSIE, N. Y.

SCHATZ
"Commercial"
BALL BEARINGS

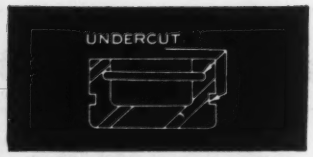
Materials Engineering Facts

HINTS FOR MOLDED PARTS OF ACE HARD RUBBER

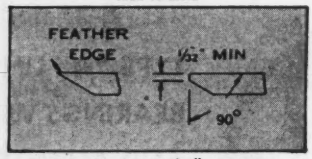
Ace Hard Rubber is a widely used thermo-setting plastic, combining outstanding chemical, physical and electrical characteristics—including high tensile strength, low moisture absorption, high dielectric strength and good machining qualities.

You can choose from Ace compounds which offer tensile strength up to 9700 psi, dielectric strength to 613 v/mil, heat resistance to 300° F. water absorption as low as 0.04—with complete (among world's largest) Ace facilities for design, molding, extruding, machining, finishing, etc.—for parts made the most economical way to your exact specifications. Also Ace plastics such as Parian (polyethylene), Saran, Ace-Tex, etc.

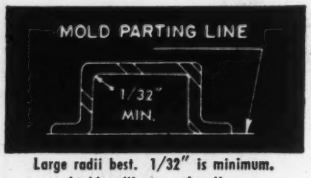
Always check your Ace Hard Rubber and Plastics Handbook when selecting materials. If you haven't a copy of this valuable 60-pg. manual, *write today —it's free.*



Undercuts usually cheaper to machine than to mold

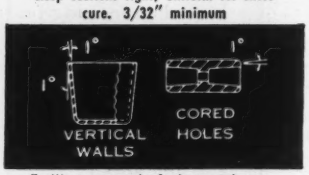


Avoid fragile edges, 1/32" is minimum

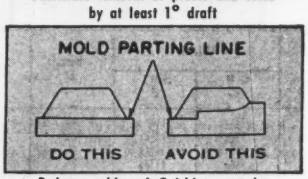


Large radii best. 1/32" is minimum. Avoid radii at parting line

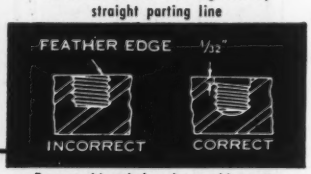
Keep sections light, uniform for short cure. 3/32" minimum



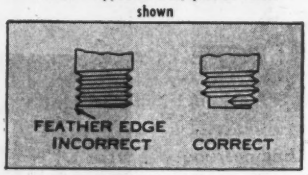
Facilitate removal of pieces and cores by at least 1° draft



Reduce mold and finishing cost by straight parting line



Prevent chipped threads; provide recess shown



Start male threads 1/32" from end

ACE AMERICAN HARD RUBBER COMPANY
Since 1851
HARD RUBBER and PLASTICS
11 MERCER STREET • NEW YORK 13, N. Y.

Tex., Associated Air Service will handle application engineering of Foote Bros. products, particularly as they relate to the aircraft industry and will be under the direction of J. A. Cleeland, who has had many years of experience in the fields of aircraft and air transportation.

♦

The Cleveland district sales office of **Heppenstall Co.**, Pittsburgh, has been moved from 311 Rockefeller Bldg. to more convenient quarters at 506 Terminal Tower Bldg.

♦

Relay manufacturers at Princeton, Ind., **Potter & Brumfield** has announced the appointment of **Rockbar Corp.**, 13 East 40th St., New York 16, N. Y. as sales engineers for the metropolitan New York and northern New Jersey territory. Potter & Brumfield has expanded its operations into the hermetically sealed relay field, particularly in military types. A number of new relay models and housings have been added to the line.

♦

The appointment of **J. L. Osgood Machinery & Tool Co.**, 43-45 Pearl St., Buffalo 2, N. Y., as western New York state representative for **National Electric Welding Machines Co.**, Bay City, Mich., was announced recently.

♦

With offices in Cincinnati, O., **Sheldon Storer and Associates** has been appointed district representative for the **Electric Products Co.** of Cleveland and will be responsible for promoting the latter company's line of synchronous and induction motors, a-c and d-c motors and generators, battery chargers, electrolytic power supplies and frequency changers. The territory covered by Sheldon Storer and Associates includes the southwestern section of Ohio and the state of Kentucky.

♦

Mine and Smelter Supply Co., 1422 Seventeenth St., Denver, Colo., has been appointed exclusive representative for **Hydro-Line Mfg. Co.'s** air and hydraulic cylinders in the Denver and El Paso, Tex. territory.

♦

Announced recently was the appointment of **Winsmith-Buffalo,** Marine Trust Bldg., Buffalo 3, N. Y., as representative for **Winfield H. Smith Corp.**, Springville, N. Y. manufacturer of speed reducers. Winsmith-Buffalo is a new company under the management and proprietorship of L. D. Aydelotte, former sales manager

How many different sleeve bearing alloys do you use?

We specialize in variety . . . in sleeve bearings and bushings. Half a century's experience has shown us that there is no universal bearing alloy to fit all needs. One automotive engine, for example, might require tin base lining for main bearings, while another might require copper-lead lining. One tractor manufacturer calls for cast, full-round piston pin bushings while another prefers rolled-type split bushings. Electric motors, Diesel locomotives, marine engines and ditch diggers all have their own special requirements. Instead of making just one type of bearing and trying to fit it to all needs, we produce "tailor-made" bearings to meet your performance specifications.

Our seven manufacturing plants are equipped to produce sleeve bearings and bushings in a wide variety of material combinations, and in many sizes—in quantities ranging from dozens to millions.

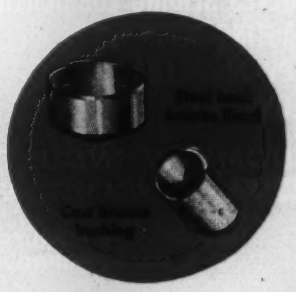
Send for our Bulletin showing the "Field of Usefulness" chart for a wide range of bearing alloys. It provides a "ready reference" on bearing applications for your library.

FEDERAL-MOGUL CORPORATION • 11045 SHOEMAKER, DETROIT 13, MICH.

Silent **SLEEVE BEARINGS**

FEDERAL-MOGUL

OVER FIFTY YEARS OF CONTINUOUS BEARING EXPERIENCE



Announcing A New LOW COST Ball Bearing for Your

LINEAR MOTIONS

BALL BUSHING

THE COMMERCIAL GRADE SERIES B

Sliding linear motions are nearly always troublesome. Thousands of progressive engineers have solved this problem by application of the Precision Series A Ball Bushing.

The low-cost Commercial Grade Series B bearing is now added to the Ball Bushing line and offered to original equipment manufacturers. This ball bearing has been developed for support of linear motions in competitively priced, volume produced products where super precision is not essential. Alert designers can now make tremendous improvements in their products by using Ball Bushings on guide rods, reciprocating shafts, push-pull actions, or for support of any mechanism that is moved or shifted in a straight line.

Competition is returning. Up-to-date engineering can be *important to you!*

- LOW FRICTION
- ELIMINATE BINDING AND CHATTER
- SOLVES SLIDING LUBRICATION PROBLEMS
- LASTING ALIGNMENT
- LOW MAINTENANCE
- LONG LIFE

NEW 1½" NOW AVAILABLE

Now in production for ¼", ⅜", ½", ¾", 1" and 1½" shaft diameters. If you have a catalog, phone your representative or write us for new Data Sheet. If not, write for complete literature and the name of our representative in your city.

THOMSON INDUSTRIES, INC.

Dept. E 〉 MANHASSET, NEW YORK

PROGRESSIVE MANUFACTURERS USE BALL BUSHINGS—
A MAJOR IMPROVEMENT AT A MINOR COST

of Winfield Smith. Sales territory will include all of New York state outside metropolitan New York City as well as Erie, Crawford, Warren and McKean counties in Pennsylvania.

♦

The **Pennsylvania Flexible Metallic Tubing Co.** of Philadelphia has appointed the **Boston Woven Hose and Rubber Co.**, 123-125 Water St., Pittsburgh, Pa., as distributor in the Pittsburgh area. This move will provide industry in the Pittsburgh area with the latest in flexible metallic hose developments and improved technical service through the facilities of a factory trained service man.

♦

A district office was opened recently in St. Louis by **Tinnerman Products Inc.**, with Carl F. Marcussen, formerly with the company's Chicago district office, as manager. The new territory consists of Missouri, Kansas and southwestern Illinois. District offices are located at 7614 Wydown Blvd., St. Louis 17, Mo.

♦

The **Riverside Metal Co.**, manufacturer of copper alloys, has established a new sales office at its headquarters in Riverside, N. J., under the direction of Robert G. Clark. The office will service the seaboard area from Richmond, Va., north to Trenton, N. J., including Maryland, Delaware, New Jersey and Pennsylvania as far west as Scranton, Wilkes-Barre and Reading. Heretofore, sales in this area have been directed from the main office. This company has also appointed the **William M. Orr Co.** of 1230 Brighton Rd., N. S., Pittsburgh, Pa., as a warehousing distributor in western Pennsylvania, eastern Ohio and West Virginia, where the company is a supplier of quality copper-base alloys.

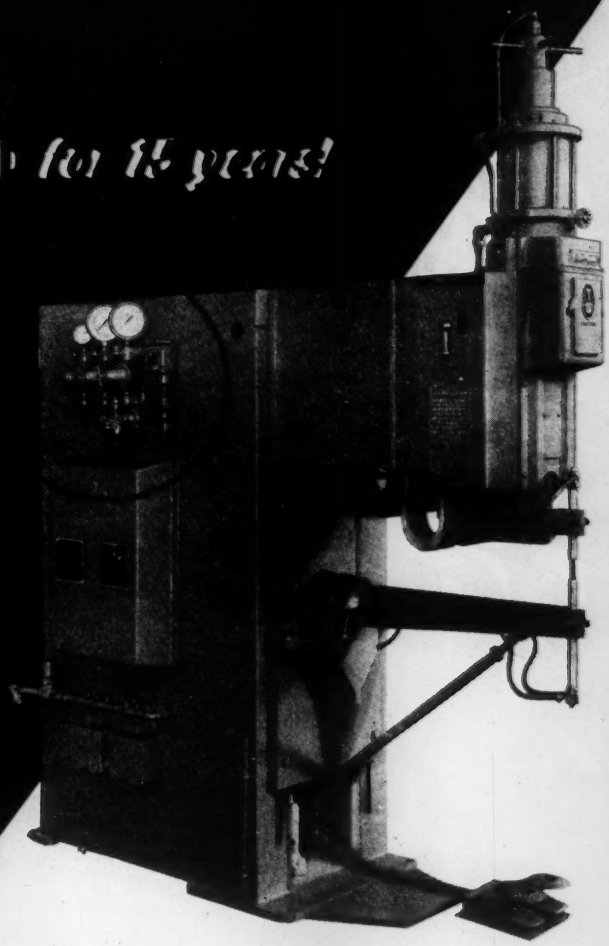
♦

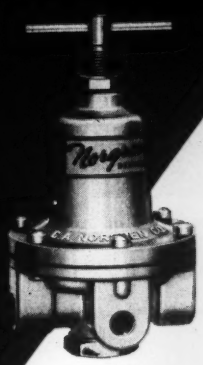
It was announced recently by the **Stow Mfg. Co.**, Binghamton, N. Y., that **Oilmen's Service and Supply Co.**, 967 Commonwealth Ave., Boston 15, Mass. is now exclusive distributor for Stow truck pump drive equipment in the New England area.

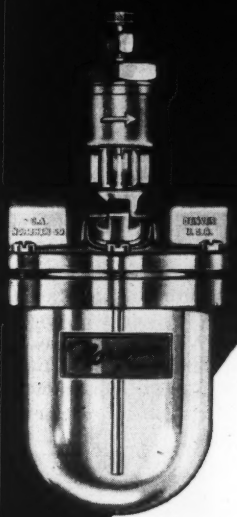
♦

Appointment of new representatives to handle Unimax precision switch sales has been announced by **Unimax Switch Division** of the **W. L. Maxon Corp.**, New York City. In the state of Wisconsin the new representative is Mark M. Hennessy, **Mae Strauss Associates**, 610 West Michigan St., Milwaukee 3, Wis., and in

Norgren 1st Choice of TAYLOR-WINFIELD for 15 years!







NORGREN REGULATORS...feature Baffle Plate and Siphon Tube action, permitting greater air flow with less pressure drop...respond faster ...protect against shocks and chatter.

NORGREN LUBRICATORS...develop air-oil fog that coats all internal parts of equipment reached by air...have visible oil feed...are refilled without shutting off the air...are compact, simple to install and maintain.

Write C. A. NORGREN CO.,
242 Santa Fe Drive, Denver 9, Colo.

Norgren

Filters, Regulators, Lubricators, Valves, Hose Assemblies.

Miller
High Pressure Hydraulic Cylinders
met J.I.C. HYDRAULIC STANDARDS years before their adoption
J.I.C. HYDRAULIC STANDARDS
FOR INDUSTRIAL EQUIPMENT
Compliments of MILLER MOTOR COMPANY
UNABRIDGED COPY of "Joint Industry Conference" Standards for specifying "quality" hydraulic equipment
SENT FREE ON REQUEST

Why Experiment? . . . Specify Miller "Time Tested and Proven" Cylinders—And Be SURE!

All Miller Standard High Pressure Hydraulic Cylinders met both the *mandatory* and *recommended* practices of the "Standards" *years ago.*

Some "Standards" specifications, such as dirt protectors, scratch-resistant piston rods, etc., are required only under severe conditions. *All* Miller *Standard* High Pressure Hydraulic Cylinders met *these* requirements *years ago.*

The desire for elimination of *manual* rod seal adjustment is strongly voiced at all hydraulic industry conferences. The *"time tested and proven"* Miller Patented Rod Seal is self-adjusting and wear compensating . . . *requires no manual adjustment.*

Complete Line

- AIR CYLINDERS 1½" to 20" Bores
- LOW PRESSURE HYDRAULIC CYLINDERS 1½" to 16" Bores
- HIGH PRESSURE HYDRAULIC CYLINDERS 1½" to 12" Bores

Single and Double Acting, Single and Double Rod End, Spring Return, Cushioned and Non-Cushioned, Over-Sized Rod, and Long Stroke Cylinders in All Mounting Styles.

write for

Miller Air Cylinder Bulletin A-105 and Miller Hydraulic Cylinder Bulletin H-104

MILLER MOTOR COMPANY

4025 N. KEDZIE AVE. • CHICAGO 18, ILLINOIS

AIR AND HYDRAULIC CYLINDERS · ACCUMULATORS · COUNTERBALANCE CYLINDERS · BOOSTERS · AIR HOISTS

Michigan, **H. W. Walton,** 1010-11 Francis Palms Bldg., Detroit, Mich. **R. L. Wilkinson** and **Samuel R. Morrow,** Rydal, Pa., will represent the company in the Philadelphia area, and **Douglas H. Loukota,** 6919 San Fernando Rd., Glendale, Calif., in California. Missouri and Kansas will be served by **Norman W. Kathrinus Co.,** 1218 Olive St., St. Louis, Mo., and southern New Jersey, eastern Pennsylvania, Maryland and Delaware, by **Willou Sales Engineering Co.,** 408 York Rd., Towson, Md.

♦

New district representative for the **Federal Machine and Welder Co.,** Warren, O., in the states of Maine, Vermont, Massachusetts, New Hampshire, Connecticut and Rhode Island is **Austin-Hastings Co. Inc.** The latter company is located in Cambridge, Mass., with branch offices in Hartford, Connecticut and Worcester, Mass. John Argento, manager of the welding division, will operate from the Cambridge office, with able sales engineers working out of the other two offices.

♦

Hereafter the line of K-C motors made by the **Kingston-Conley** division of the **Hoover Co.** will be known as "Hoover electric motors," after the name of the parent company and maker of the Hoover cleaner.

♦

The appointment of the **G. W. Bush Co.,** 601 Park Ave., West Hartford, Conn., as exclusive New England distributor of their precision gears and flexible gear couplings has been announced by the **Sier-Bath Gear & Pump Co. Inc.,** North Bergen, N. J. The G. W. Bush Co. was formerly the Power Transmission division of the **Hartford Special Machinery Co.** Gordon W. Bush became owner of the division in March of this year.

♦

Henry F. Smith and Son of Cincinnati, O., has been named sales representative of **Welding Machines Mfg. Co.,** Detroit, Mich., for the Indiana territory. H. Christa Smith will be in charge of the line for Henry F. Smith and Son.

♦

The New York sales division of **Sylvania Electric Products Inc.** recently was moved to new headquarters at 1740 Broadway, New York 19, N. Y., bringing together divisions and departments in the New York area. Offices are now located on the fourteenth, fifteenth and sixteenth floors of the new Mutual Life Bldg.

It's easier with HYATT HY-LOADS

IN ADDITION to the "A-TS" bearing illustrated there are nine other major types of Hyatt Hy-Load Roller Bearings. Four have separable inner races, two have separable outer races and four are non-separable thus giving a designer a wide choice of bearings which permits flexibility in machine design and assembly procedures.

The "A-TS", one of the separable inner race type, is a high capacity cylindrical roller bearing made in two diameter series, wide and narrow widths, to standard AFBMA boundary dimensions.

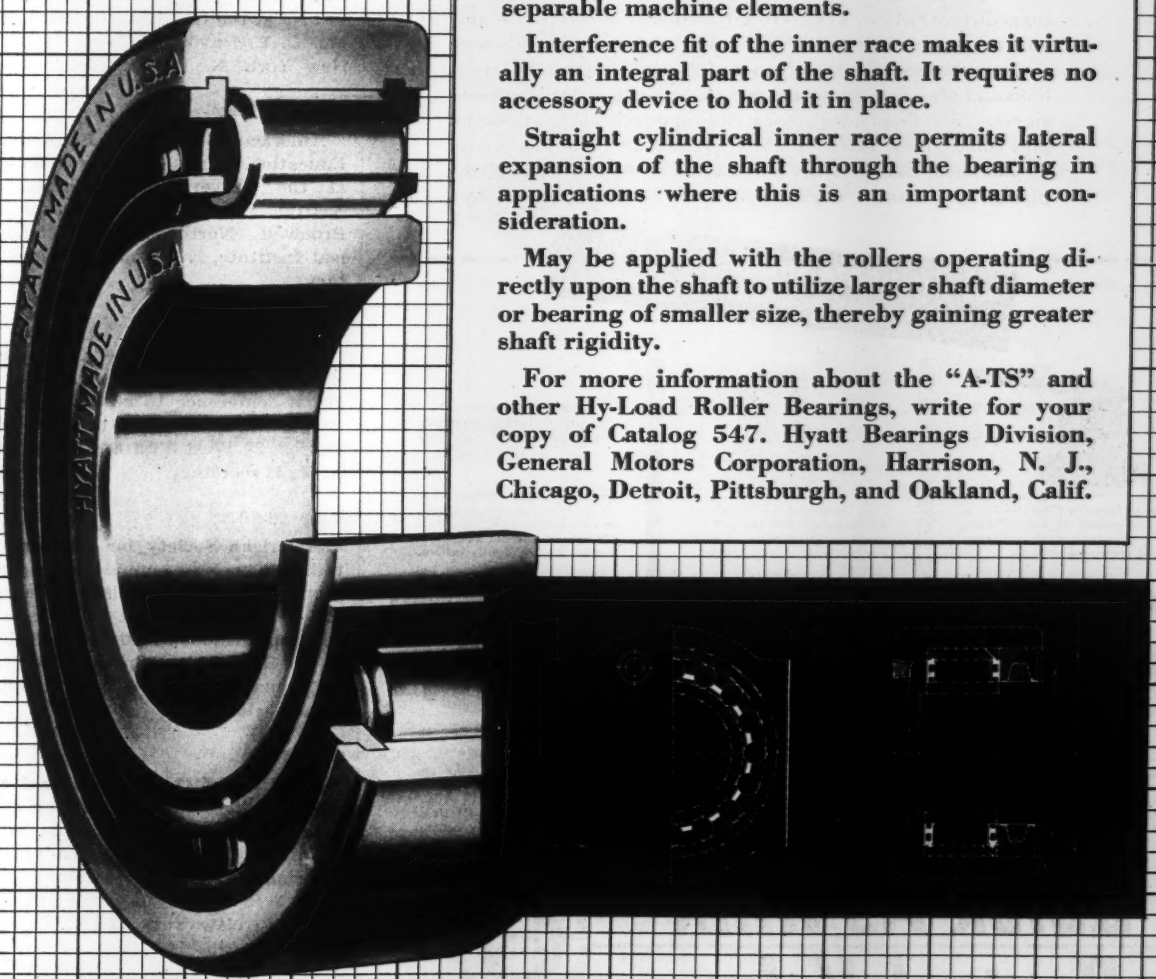
Separable parts are freely interchangeable. Any inner race will fit any roller assembly of the same piece number. This permits non-selective fitting after pre-assembling the two bearing parts in separable machine elements.

Interference fit of the inner race makes it virtually an integral part of the shaft. It requires no accessory device to hold it in place.

Straight cylindrical inner race permits lateral expansion of the shaft through the bearing in applications where this is an important consideration.

May be applied with the rollers operating directly upon the shaft to utilize larger shaft diameter or bearing of smaller size, thereby gaining greater shaft rigidity.

For more information about the "A-TS" and other Hy-Load Roller Bearings, write for your copy of Catalog 547. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J., Chicago, Detroit, Pittsburgh, and Oakland, Calif.

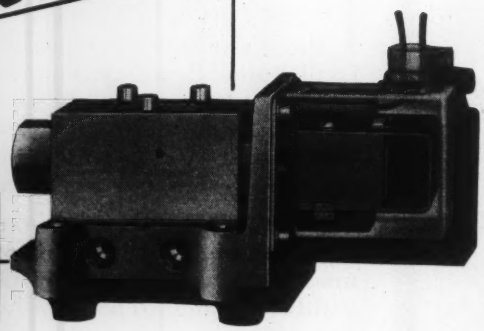


HYATT ROLLER BEARINGS

NEW INEXPENSIVE

High Cycle SOLENOID VALVES

1/8" and 1/4" sizes up to 300 cycles per minute

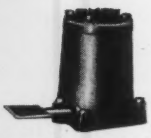


. . for air to 125 P. S. I. — or vacuum also low pressure hydraulic service

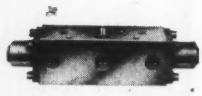
● These valves combine the utmost simplicity in design with rugged construction. They will give millions of cycles of highly satisfactory and efficient trouble-free service. Small solenoids, with short strokes work against the valve plunger, eliminating levers, links and pins. Low amperage requirement eliminates intermediate relays and simplifies electrical control circuits. Side or bottom pipe connections. Valve body and solenoid are both mounted on an aluminum base and can be removed without disturbing the piping. 2, 3, 4 and 5-way actions. ***Write for Data Sheet No. 1741.***

Individual **DATA SHEETS** for Each Valve — give complete details. Write today!

Hand Operated Air Valves—wide variety of uses. 2-way, 3-way, 4-way neutral position and compound exhaust.

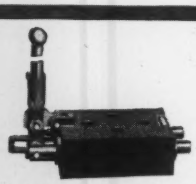


Foot Operated Air Valves—workman has both hands free, speeding production. 2-way, 3-way and 4-way actions

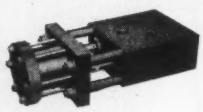


Single Plunger Valves—for air or low pressure hydraulic service. Lever, pilot, cam, diaphragm or solenoid operated. 2-way, 3-way, 4-way actions.

Series "O" and "OE" Valves—for air or hydraulic service up to 125 PSI. Push-pull, cam, pilot, diaphragm and solenoid operated. 1/8" and 1/4" pipe connections. 2-way, 3-way, 4-way and 5-way actions.



Hydraulic Valves—Up to 5000 PSI. Conservatively rated. 1/2", 3/4", 1" and 1 1/2" sizes. 2-way, 3-way, 4-way actions.



Hydraulic Valves—Up to 5000 PSI. Pilot cylinder operated. 1/2", 3/4", 1" 1 1/2" 2", 2 1/2" 3" and 4" sizes 2-way, 3-way, 4-way actions.

Quick-As-Wink Control Valves

THE HIGHER THE PRESSURE THE TIGHTER THE SEAL

Manufactured by **C. B. HUNT & SON, Inc.**

1911 East Pershing Street, Salem, Ohio

MEETINGS AND EXPOSITIONS

June 12-16—

American Institute of Electrical Engineers. Summer and Pacific general meeting to be held at the Huntington Hotel, Pasadena, Calif. H. H. Henline, 33 West 39th St., New York 18, N. Y., is secretary.

June 19-21—

American Society of Agricultural Engineers. Annual meeting to be held at the Statler Hotel, Washington, D. C. Raymond Olney, P.O. Box 229, St. Joseph, Mich., is secretary.

June 19-23—

American Society of Mechanical Engineers. Semi-annual meeting to be held at the Hotel Statler, St. Louis, Mo. C. E. Davies, 29 West 39th St., New York, N. Y., is secretary.

June 19-23—

American Society for Engineering Education. Annual meeting to be held at the University of Washington, Seattle, Wash. Prof. Arthur B. Bronwell, Northwestern Technological Institute, Evanston, Ill., is secretary.

June 22-24—

American Society of Mechanical Engineers. Applied mechanics division conference to be held at Purdue University, Lafayette, Ind. C. E. Davies, 29 West 39th St., New York, N. Y., is secretary.

June 26-30—

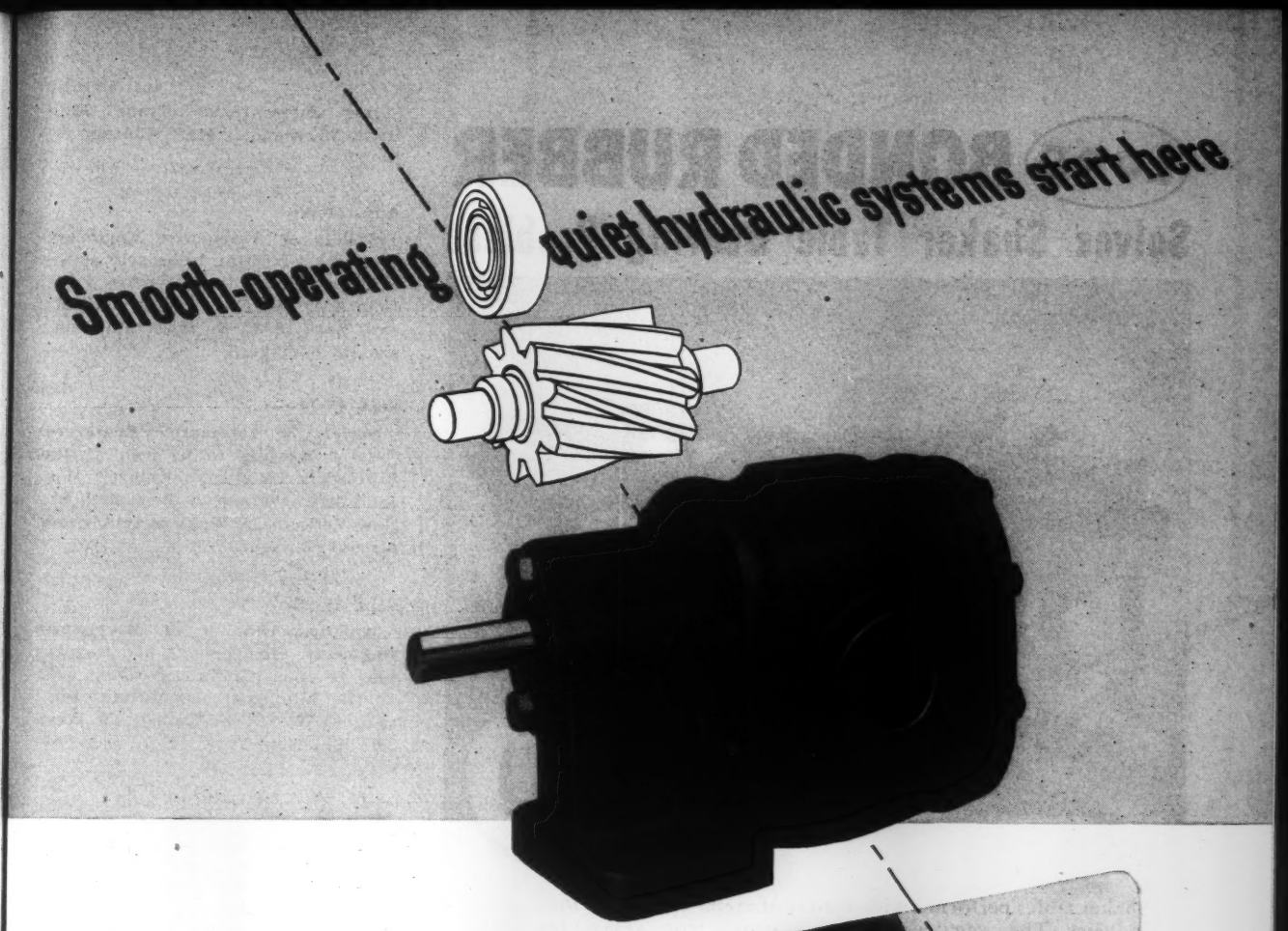
American Society for Testing Materials. The 53rd annual meeting and ninth exhibit of testing apparatus and related equipment to be held at Chalfonte-Haddon Hall, Atlantic City, N. J. Robert J. Painter, 1916 Race St., Philadelphia 3, Pa., is assistant to the secretary.

July 12-14—

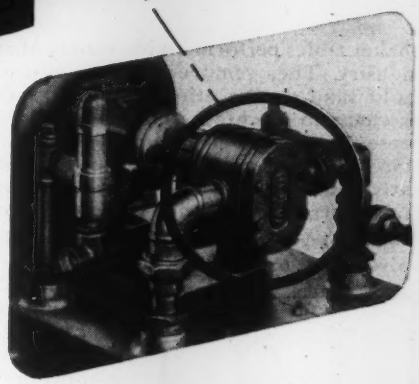
Institute of the Aeronautical Sciences. Annual summer meeting to be held in the Western Headquarters Bldg., Los Angeles, Calif. Additional information may be obtained from Robert R. Dexter, Secretary, 2 East 64th St., New York 21, N. Y.

Aug. 7-19—

International Trade Fair to be held in the Coliseum, Arena, International Amphitheater and Navy Pier, Chicago, Ill. Additional information may be obtained from the First United



Rotary Geared Pumps with Helical Gears and Roller Bearings



Here's an easy way to add extra features to the design of hydraulically-operated machines . . . a quiet-operating pump that provides smooth continuous flow. By specifying Brown & Sharpe Rotary Geared Pumps with helical gears made to extreme accuracy and operating on roller bearings, you can assure these features. What's more, trouble-free service life of the pump is extended too!

Brown & Sharpe Rotary Geared Pumps with helical gears and roller bearings are made in two sizes: No. 53 — 4 to 23.3 gallons per minute at 0 lbs. pressure; and No. 55 — 9 to 34.1 gallons per minute at 0 lbs. pressure.

Although designed for direct drive, these pumps may be driven by pulley or gear. Made to run in one direction only, either clockwise or counterclockwise. Leakage and gland adjustments present no problems because the pumps have a mechanical seal.

Let these pumps help you *advance* your machine design by supplying oil under pressure for hydraulically-operated machines, or for lubrication systems where quietness is essential. Get all the facts. Write for Pump Catalog. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

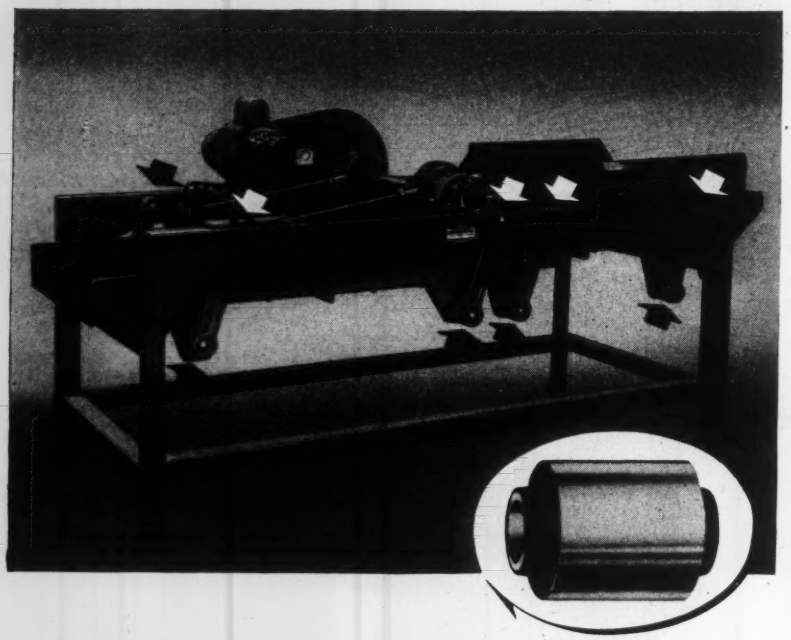
GEARED • VANE • CENTRIFUGAL • MOTOR DRIVEN PUMPS

We urge buying through the Distributor

BROWN & SHARPE PUMPS B·S

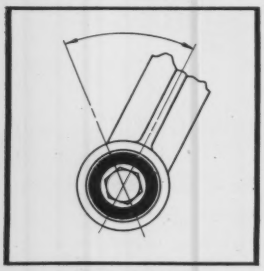
LORD BONDED RUBBER

Solves Shaker Table Bearing Problem



Shaker tables perform a wide variety of useful operations throughout industry. They remove soil and moisture from vegetables, shake mold sand from castings, grade gravel to size, and steadily feed products to machines and processes. Most operations involve the presence of grit and moisture—notorious enemies of bearing life. Hanger arm bearings developed noise, wore rapidly and failed early. The problem was to find bearings which would give satisfactory service life under such conditions.

Commercial Manufacturing & Supply Company, Fresno, Calif., solved the problem by using standard LORD Bonded Rubber Mountings. Torsional movement caused by reciprocating action of the shaker is accommodated by the flexibility of rubber. Installation is simple because mountings are small, compact units which are pressed and bolted in place. Since there are no frictional surfaces, moisture and abrasives have no effect. Longer bearing life, smoother operation and quieter performance resulted from the change to LORD Bonded Rubber.



BEARING ACTION

Many design problems which require accommodation of relative movement can be readily solved by LORD Bonded Rubber (rubber-bonded-to-metal) Mountings. Noise and vibration can be isolated to make better, more salable products. For information and assistance in selecting and applying LORD Bonded Rubber parts, write to attention of Product and Sales Engineering Dept.

LORD MANUFACTURING COMPANY · ERIE, PA.

Canadian Representative: Railway & Power Engineering Corp. Ltd.

LORD BONDED RUBBER — *Vibration Control Mountings and Bonded Rubber Products*

States International Trade Fair, 10316 Merchandise Mart, Chicago 54, Ill.

Aug. 14-16—

Society of Automotive Engineers. West coast meeting to be held at the Biltmore Hotel, Los Angeles, Calif. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

Sept. 11-14—

Society of Automotive Engineers. Tractor meeting to be held at the Schroeder Hotel, Milwaukee, Wis. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

Sept. 18-22—

American Society of Mechanical Engineers. Instruments and Regulators Division Conference to be held at the Municipal Auditorium, Buffalo, N. Y. C. E. Davies, 29 West 39th St., New York, N. Y., is secretary.

Sept. 18-22—

Instrument Society of America. The fifth national conference and exhibit to be held in the Memorial Auditorium, Buffalo, N. Y. Richard Rimbach, 1117 Wolfendale St., Pittsburgh 12, Pa., is executive secretary.

Sept. 19-21—

American Society of Mechanical Engineers. Fall meeting to be held at the Hotel Sheraton, Worcester, Mass. C. E. Davies, 29 West 39th St., New York, N. Y., is secretary.

Sept. 25-27—

American Society of Mechanical Engineers. Petroleum mechanical engineering conference to be held at the Hotel Roosevelt, New Orleans, La. C. E. Davies, 29 West 39th St., New York, N. Y., is secretary.

Sept. 26-29—

Association of Iron and Steel Engineers. Annual iron and steel exposition to be held at the Cleveland Public Auditorium, Cleveland, Ohio. Additional information may be obtained from Society headquarters, 1010 Empire Bldg., Pittsburgh 22, Pa.

Oct. 16-18—

Society of Automotive Engineers. Transportation meeting to be held at the Statler Hotel, New York, N. Y. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

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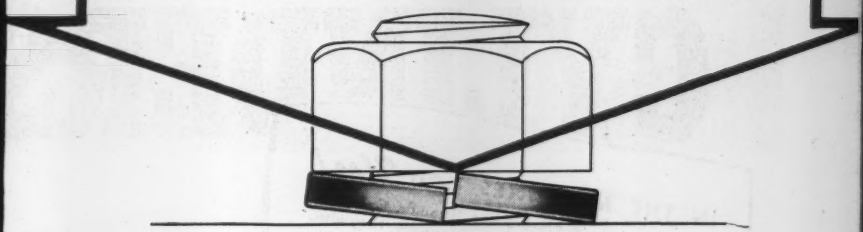

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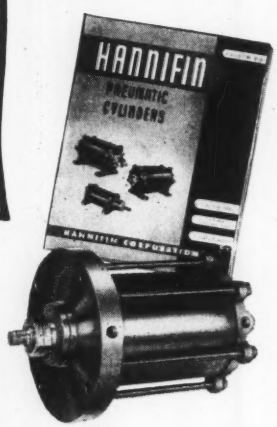

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DESIGN ABSTRACTS

Postgraduate Training For Leadership

Never have there been so many opportunities for technical men in the top level jobs of American industry. The efficient operation of today's complicated civilization depends on leaders who can guide and co-ordinate the forces of science and industry. Businesses, large and small, are crying for technically trained men who are proficient in their own fields but also have the broader education that enables them to cope with economic and social problems.

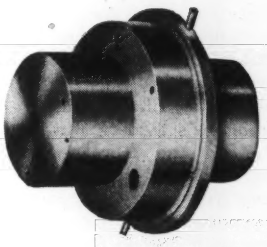
The difficulty in finding such leaders right now is complicated by the fact that there is also an ever-increasing need in industry for more intensive specialization—particularly in the physical sciences and their engineering applications. Thus, our educational authorities are posed with a problem in which industry has or should have an absorbing interest.

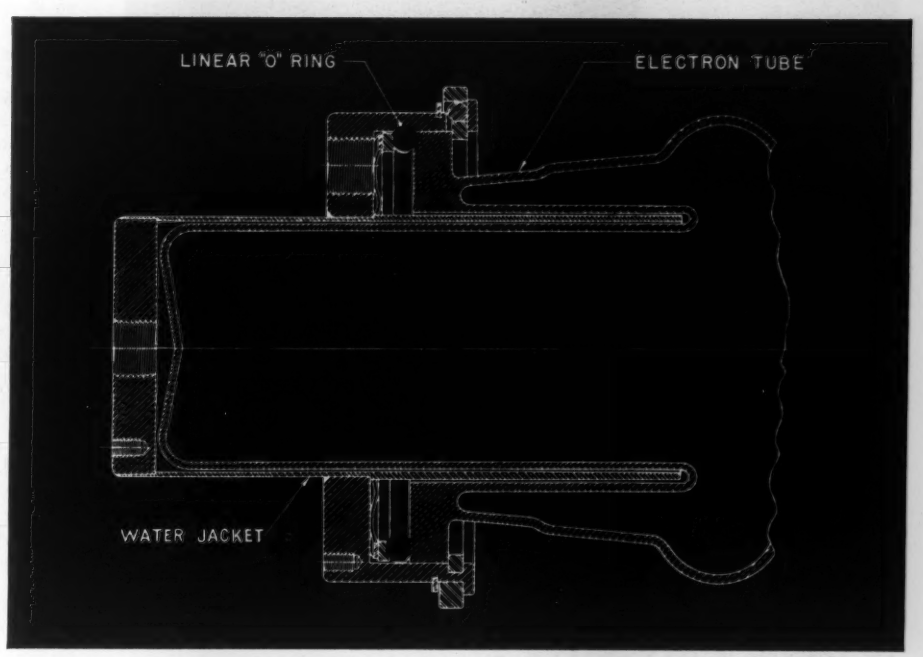
There are several reasons for the present-day scarcity of well-trained executives. Industries have grown tremendously in size and number, as well as complexity, in recent years. Today's payrolls are several times those of a decade ago. The last census shows that between 1939 and 1947 employment increased by 50 per cent while wages rose 235 per cent. Engineering employment has grown since 1890 from 27,000 to 350,000—some four times as fast as the total number of workers. Will this ratio continue? The chances are it will. Someone has estimated that there are 220,000 small manufacturing companies in the U. S. without the services of a single professionally trained engineer.

High Executive Age Level

Another reason for the shortage in managerial talent is the fact that many of the junior executives who should now be stepping into their bosses' shoes have had their progress interrupted by three or four years of service for Uncle Sam. The result is an abnormally high age level for executives in most industries.

A survey made not long ago showed that the executive staffs of corporations now average 7 years older than they did two decades ago. Corporation presidents in 1929 averaged 53 years of age; in 1949, they were 59. Even junior officers had aged from





TIP...

FOR THE DESIGNER

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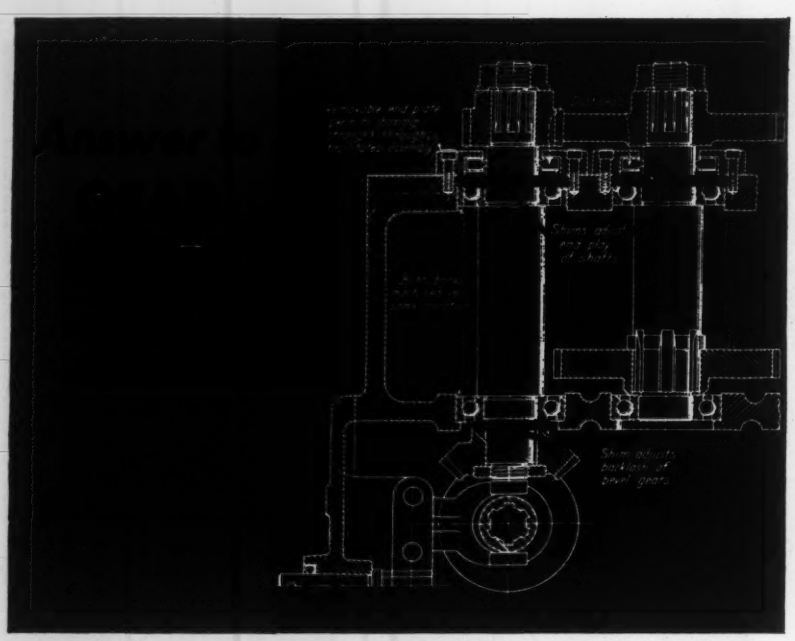

IF YOU'RE WASTING TIME AND TYING UP A STANDBY LATHE . . .

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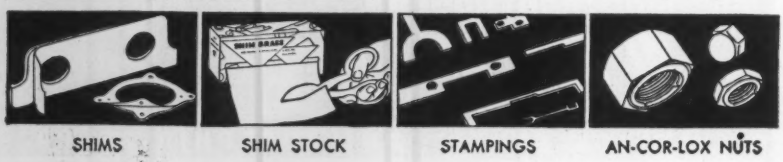


SHIMS SHIM STOCK STAMPINGS AN-COR-LOX NUTS

an average of 46 to 52, while all executive officers (including board chairmen) had increased in age from 47 to 54 years.

Replacements will have to be made in the next 5 to 10 years at a much more rapid rate than has been the case in the past. Retirement plans and physical strain on older men will take an increasingly heavy toll. Truly there is a greater need for leaders all along the line, from foremen and group supervisors to plant managers and top executives.

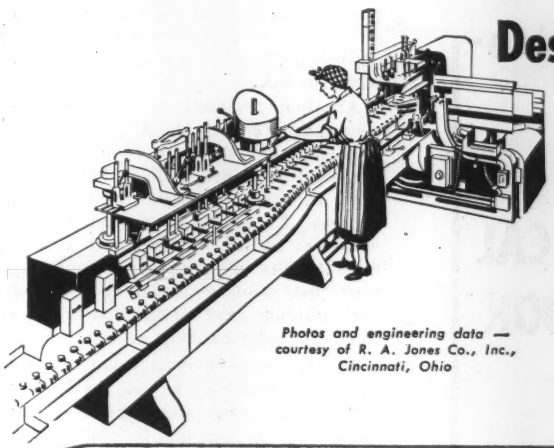
Our difficulty in finding and developing tomorrow's leaders can also be attributed to the increased responsibilities that must now be carried by executives of modern industry. It is no longer safe to pick a man who has made a success in some specialized field of knowledge and assume that he will be equally successful in a broader application of that knowledge in industrial administration. We have all seen mistakes made in our own companies that might have been avoided had those in authority been better schooled in economic and social relations.

Institutions To Blame?

At least a part of the blame is being placed at the doors of our educational institutions. Recently 100 doctors, lawyers, businessmen, clergymen and engineers sat down to discuss professional education. Their most frequently voiced objection was that the professional schools are turning out technically educated but socially irresponsible graduates who are useless to or actually dangerous to society. None of us want to go that far, I am sure, but I think we can agree that this is not just an academic problem. It is something that we can and should do something about—both in our universities and in industry.

To a certain extent this problem has sneaked up on us. The need for specialization has grown gradually. More and more technical courses have been crowded into curricula—too often at the expense of the social sciences and humanities. Application courses have supplanted fundamentals. Fewer and fewer electives have been offered as four-year courses have been standardized to meet the "average" thinking of accrediting agencies. The fault is ours as much as theirs.

What should be done? One way is to lengthen the course to five or six years and use the additional time to make up for inadequacies in social studies. But here we are up against strong objections on two scores—added cost and because most of our younger men (as well as their parents) want to get their college edu-

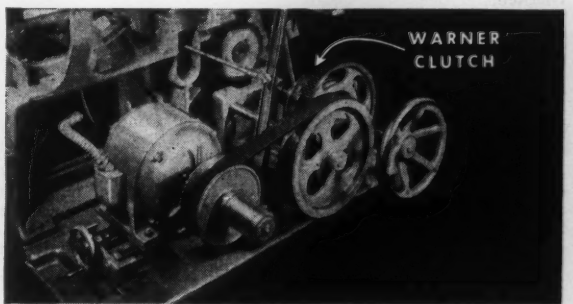


Photos and engineering data — courtesy of R. A. Jones Co., Inc., Cincinnati, Ohio

Designers of new automatic cartoning machines use WARNER ICB UNITS to get "smoother starting torque, closer balance of overload torque and faster stopping."

IF YOUR PROBLEM

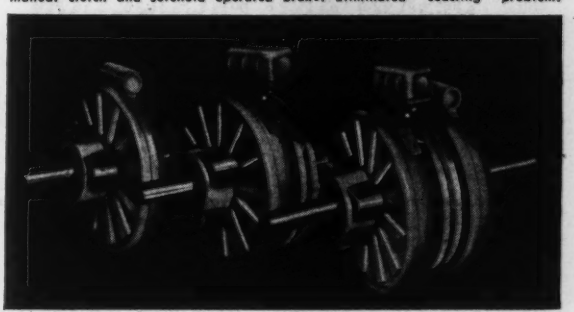
is to design your machine or its activating parts so that *you get:* (1) Push-button actuation at the machine or a remote control panel. (2) Fully or semi-automatic operation in "stop" or "start" of machine cycles. (3) Controlled acceleration or deceleration. (4) Automatic or manual adjustment of torque to load . . . or if your problem is *to eliminate:* (1) "Shock" from stop or start on gear trains and shafts. (2) Complex mechanical lever linkage, or air and hydraulic piping systems. (3) Vibration and hammering from solenoid operated brakes and clutches . . . or if you want to *increase production* from your machine by increasing the speed and number of cycle operations —



Here's WARNER ICB UNIT installed on drive unit of the constant motion vertical cartoner. ICB Unit improved machine performance and easily replaced manual clutch and solenoid operated brake. Eliminated "coasting" problem.

A GOOD SOLUTION

to any one or combination of these problems is WARNER ICB Units. WARNER ICB Units are electrically controlled and operated clutches and brakes. They are compact, mechanically simple and may be applied to machine spindles, drive shafts, or direct to electric motors. Because of their design, they may be operated individually or in combination, manually or automatically, by direct or remote control. They provide for infinite controlled variation of torque in either clutching or braking action within their rated capacities. Their action is smooth and shockless—fast and practically noiseless. They are self-adjusting and self-compensating for life. Their design guarantees a high rate of heat dissipation.



From left to right: a Warner ICB Brake Unit, a Warner ICB Clutch Unit, and a combination Warner ICB Clutch and Brake Unit. Note clean, smooth, compact, appearance — simple mechanical parts.

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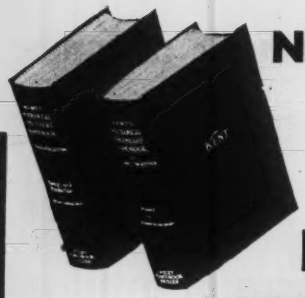

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cation behind them in the shortest possible time. Most of them want to get their professional degrees primarily to get jobs, to buy groceries, and who can blame them?

Another proposal is that all engineering students should be required to spend two, three, or four years in a more liberal arts college before being admitted to the professional courses. To quote one famous but nameless father, "They go to ridiculous lengths in giving the impression that just reading Virgil and Homer and studying dead civilization unlocks the real understanding of life."

The industry-university partnership idea is a challenging one. As in any partnership, each must gain if the venture is to prove successful—and each will lose if it fails. More and more our colleges must train for careers—not for jobs. Industry is looking for men with high potential in technical and management fields, men who are well-grounded in their engineering fundamentals and who have the personal qualities essential to teamwork. It wants men capable of maintaining an "ascending growth curve" who can continue to progress through self-development and resourcefulness. *From a talk by Sidney D. Kirkpatrick, vice-president, McGraw-Hill Book Co., at dedication of the Sever Institute of Technology at Washington University.*

Glass Fiber Preforms

FOR many years it has been a recognized fact that laminated plastics have physical properties superior to those produced by compression, transfer, or injection molding. The greater strength of the laminated parts is attributed primarily to the long-fibered forms of reinforcing materials utilized. Most of the reinforced plastics work to date has been done with the high strength glass fibers which exhibit excellent impact strength as well as chemical durability. However, the long reinforcing glass fibers are not easily incorporated in the compounds used for molding operations.

Considering the slow, laborious process by which laminated formed parts are produced, it is easy to see why they are expensive and not more competitive with formed metal parts. The glass fabric or glass mat sheets, which are made up of long-reinforcing fibers that give laminated parts their strength advantage, also impose process disadvantages when formed parts are considered. Most of the basic reinforcing sheets will stretch very little, and it becomes necessary to tailor these sheets to fit the molds.

High labor costs of this type of

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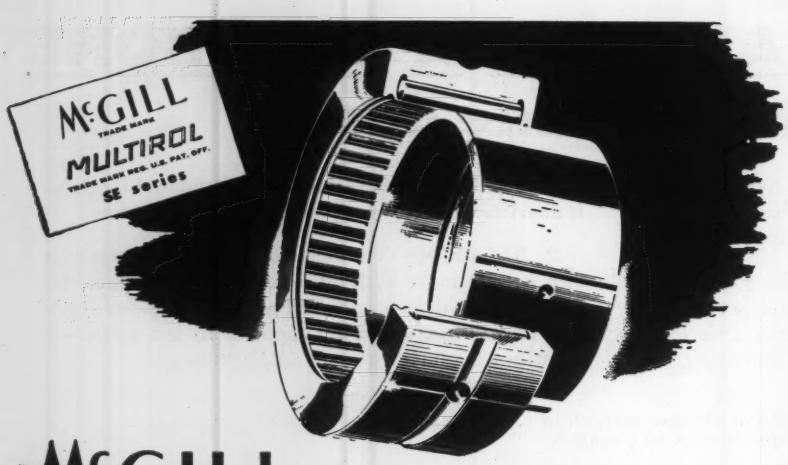
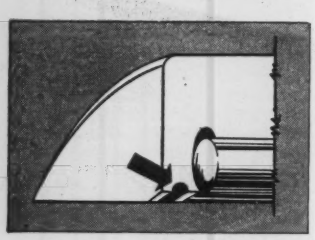


McGILL design
provides EXTRA oil seal protection



Extra protection against destructive foreign particles is provided by this lubricant-retaining groove, built into the inside diameter surface of the roller retaining-end shoulder. The ring of lubricant, held in this groove, acts against the inner race O.D., increasing the sealing effect of the precision tolerances between these shoulders and the inner race. Notice, too, the groove above the rounded end of the roller. Acting as a lubricant reservoir, this provides Multirol SE Series bearings with an extra margin of protection against neglected or delayed lubrication.

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McGILL® precision bearings

manufacture has restricted application to those articles where physical properties were at a premium and cost was secondary. However, recent developments in fiber preforming, together with compression molding techniques, have opened the new markets anticipated many years ago for low-cost reinforced plastics articles.

In essence, the fiber preforming process is based upon the air collection principle of depositing fibers on a metal screen. This idea has been used by the hat felting industry for many years. Short strands of glass fibers are separated by picker rolls and discharged into a suction chamber. At the bottom of the chamber is a turntable which holds a perforated metal screen of the size and shape of the finished article. Air is exhausted through the screen, causing the fibers to deposit on the surface. Distribution of the fibers on the screen is regulated by the screen design and control of air flow in the chamber.

A bonding agent is applied while the fibers are being collected on the screen. The preform is then placed in an oven to fuze the binding agent to the fibers and give the preform sufficient strength for the subsequent molding operation. After the preform is removed from the screen, it is placed in a mold similar to those used in compression molding and polyester resin is added to mold the piece.

Lower Unit Price

Although the use of this method in manufacturing reinforced plastic articles is relatively new, some large volume items formerly made out of porcelain enameled steel, aluminum and wood (such as washing machine tubs and covers, safety helmets, tote boxes, and dishwasher housings) have been replaced, among other parts, by preformed moldings.

The economic advantages of the preforming method over the use of flat glass-fiber mats occurs only when formed or complex contoured shaped are to be made. The economic advantages of preforms disappear when glass-mats can be used for flat panels or very shallow parts. Some fabricators are producing preform molded pieces for about $0.80 to $1.40 per lb depending upon the size and quantity required. This might seem high but, on certain items, reinforced plastics have replaced aluminum, wood, and porcelain steel at a lower unit piece price.

Glass-fiber preforming is still a new process and developments are being made constantly. The highest production rates possible on preforms have not yet been reached. Although

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CUTS COSTS 51%...WEIGHT 35% BY CONVERTING TO WELDED DESIGN

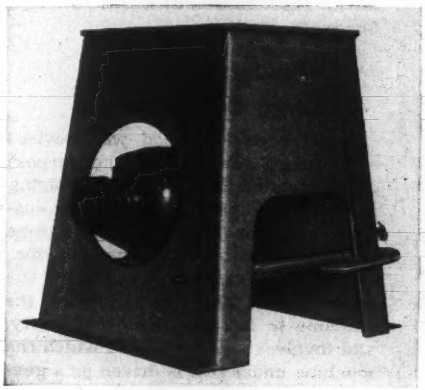

Fig. 1. All welded steel base *for shoe perforating machine.*

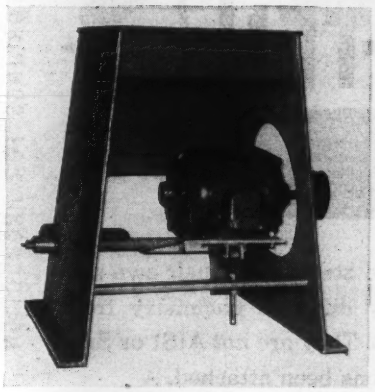

Fig. 2. Simplified, welded construction *is made by using sheared plate.*

Fig. 3. Original design, *base required machining before assembly.*

By Chesterton S. Knight, Plant Manager
George Knight & Co., Brockton, Mass.

By converting to arc welding, we are simplifying many of our designs and are substantially offsetting the effect of generally rising shop costs. In replacing the former type of construction with welded steel, we also eliminate the need for patterns as well as many machining operations formerly needed for finishing. Our products now are more rugged and have a modern-style appearance too, for greater sales appeal.

Shown in the photographs is a typical reconversion of the base for our shoe perforating machine. Originally weighing 269 lbs., the part cost $83.13 machined and ready for assembly. The present all welded steel unit weighs only 176 lbs. and costs $39.00. The new design, furthermore, has more than 50% greater strength than the original base.

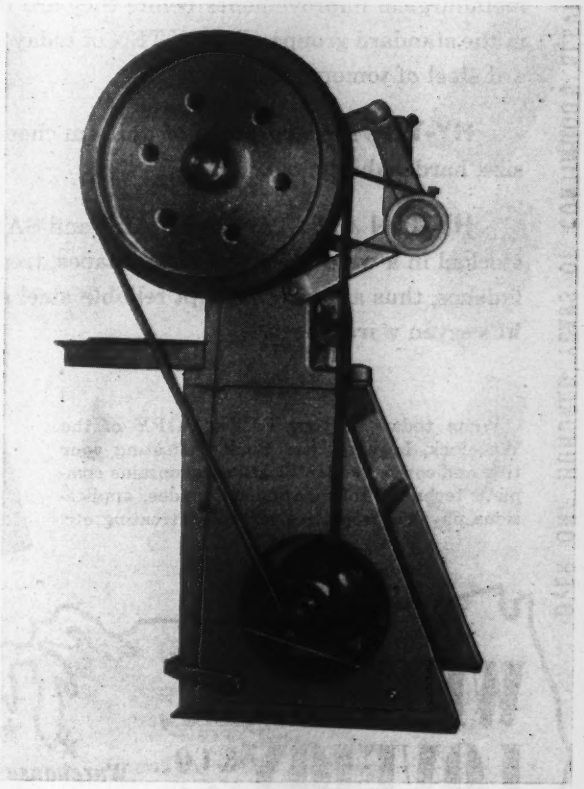

Fig. 4. Shoe perforating machine *with swing type electric motor pedestal adaptable to take up on belt tension.*

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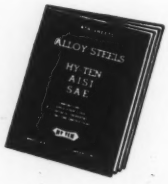
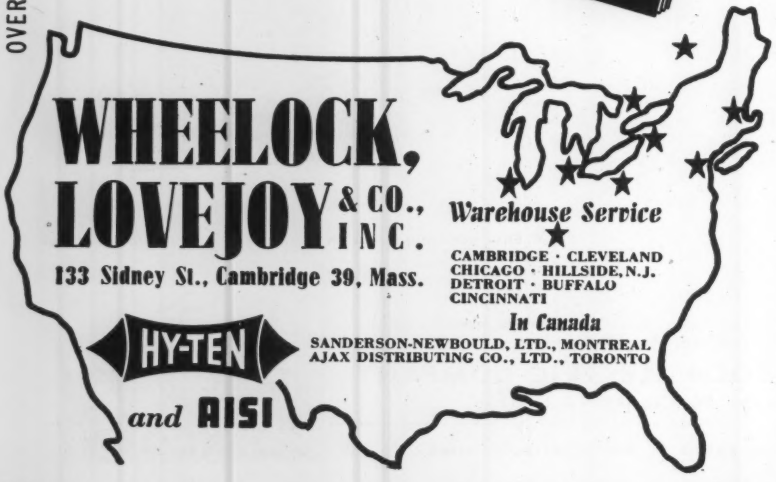

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by using three preform screens at once, one fabricator has been able to produce 100 safety helmet preforms per hour, larger items require more time since the preform machine capacities at the present time cannot handle over 150 lb of glass per hour. *From a talk given by Sol Fingerhut, Zenith Plastics Co., at S.D.I. meeting, Coronado, Calif.*

Production Testing Large D-C Equipment

A TESTING method was devised during the war for the purpose of shortening the time and avoiding some of the inaccuracies in the customary methods of making routine production tests on large d-c machines. It is based on the use of the reluctance of the flux paths of the machine to indicate their uniformity, and involves a procedure in which the machine under test is driven as a generator without load. Results obtained during many months of factory use have amply demonstrated the superiority of this method as a quick check on standard production machines. After a new type of machine is tested and all adjustments have been made from a design standpoint the problem is then one of making all succeeding machines like the first one.

Load tests provide an adequate means of determining that no parts are rubbing, that the commutator is reasonably smooth, and that the bearings are free and properly lubricated. Readings of speed and commutation are customary and serve to indicate, in a rough way, whether a machine is working as it should. Frequently the service application of the machine is such that this is an adequate check. As the specific output of motors and generators is increased, more accurate gages of speed and commutation adjustment are needed. With ordinary load testing, a good test on either of these points involves the use of a controlled condition of brush fit that is generally known as a full face load fit.

The method used in testing some three hundred machines during the war pointed the way to the development of a short commercial test for production machines. It is well known that the uniformity of the magnetic circuit in a given machine may be determined by checking its reluctance. This method has had wide commercial application for indicating the uniformity of the exciting flux path variables within acceptable limits. In the case of the three hundred machines mentioned it was also used with great success to indicate the uniformity of the commutating flux path.

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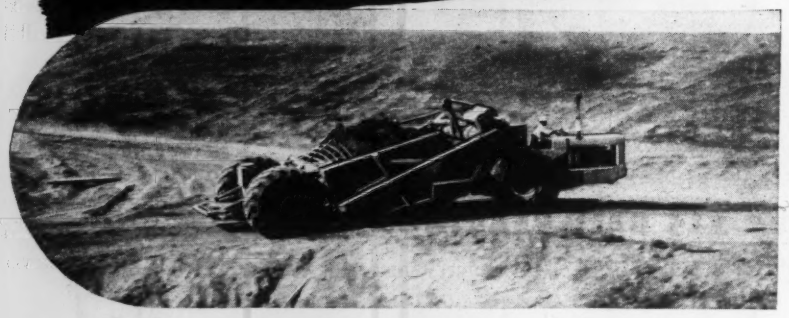
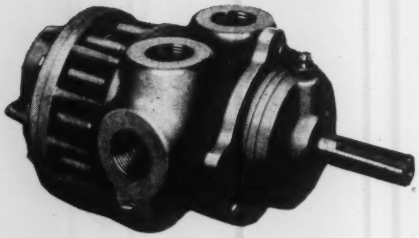


THAT'S WHY ROPER PUMPS ARE USED ON MODEL B TOURNAPULLS*



"B" Tournapulls hauled 77,000 cu. yds. of gravel on this levee building project in California. The Roper 17F Pump is an important part of this LeTourneau earthmover.

Rugged Roper Pumps are an integral part of Tournapull's* Transmission lubricating system. These pumps carry essential oil to vital transmission bearings. The main oil line has trunks extending to various bearing positions . . . the Roper 17F3 Pump is driven off the compound shaft gear and is turning continuously in this application.

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tests made it possible to build special equipment for the development of this method of indicating the commutation to be expected so that it could be applied to the commercial testing of traction motors on a high production basis. This application has made possible a complete revamping of the commercial test routine with numerous beneficial results.

Fundamentally the schedule followed consists of four simple tests plus the customary overspeed, high-potential, and hot impedance tests.

1. A no-load saturation curve is taken with the main poles excited and the armature driven at a fixed speed. This curve is used to indicate uniformity of main flux circuit reluctance, including the accuracy of the main pole air gaps. This, in turn, gives an indication of the full load speed.

2. A no-load saturation curve is taken with only the commutating poles excited and the armature driven at a fixed speed. This curve is used to indicate uniformity of commutating flux circuit reluctance including the accuracy of the commutating pole air gap. This, in turn, gives an indication of the grade of commutation to be expected.

3. The machine is operated for heating up and bearing test, at load speed with load current in the armature and commutating field, but with no main field excitation. Incidentally, variations in the power necessary to drive the machine in this test have been found to be an indication of the symmetry of the brush holders, the commutating poles, and the main poles.

4. High voltage run (45 volts per bar) is made, driving the hot armature at about 10 per cent overspeed during the test.

Not A Substitute Test

The test described above is in no way a substitute for conventional developmental load testing which, as ever, is required in making adjustments on the first machine built. Neither does it eliminate the periodic load test as a check on machine quality. The new method, however, serves to indicate that the succeeding machines are like the first one, not only in that they will run, but also in that the speed and commutation will be like the first one tested. This is the factor upon which an accurate check must be made in the machines where close commutation adjustment is essential to successful operation. *From a paper by M. J. Baldwin and H. D. Barnhart, Motor Engineering Div., General Electric Co., presented at Jan.* 1950 *AIEE Winter General Meeting in New York.*

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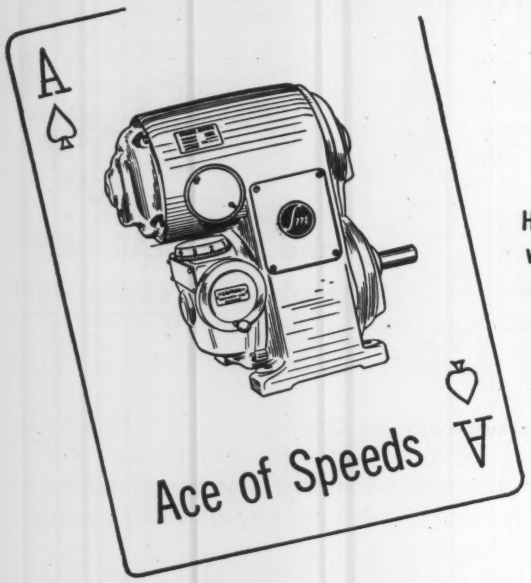

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PRESS. Capacity, 85 tons. Open-back, inclinable model features one-piece alloy frame with built-in tie rods for added rigidity. Includes Press-Rite nonrepeat single-stroke mechanism. Bolster area, 22 by 36 in.; depth of throat, 12 in. Shut heights and strokes optional. Floor to center of crank height, 78½ in. Sales Service Machine Tool Co., St. Paul, Minn.

MILLING MACHINE. New No. 3MI model features complete hand and power, front and rear controls, is powered by 7½-hp motor. Has 16 spindle speeds from 25 to 1500 rpm, 16 feed rates from ¼ to 30 in. per min, rapid traverse at 150 in. per min longitudinal and cross and 75 in. per min vertical. Built in plain and universal styles. Cincinnati Milling and Grinding Machines Inc., Cincinnati, O.

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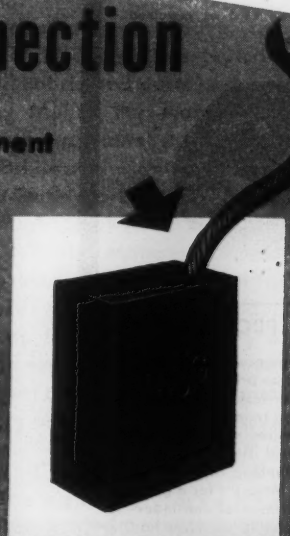

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COUNTER WHEEL PRINTER. Prints numbers on peripheral face of counter, speedometer or other indicator wheels. Prints 9 to 12 wheels per minute when hand operated, prints up to operator's ability to load if motor driven. Uses synthetic, acid-resistant rubber characters molded to steel hub and enamel or special printing ink. Wheel placed on mandrel which is geared to rotate at same speed as printing rolls. The Acromark Co., Elizabeth, N. J.

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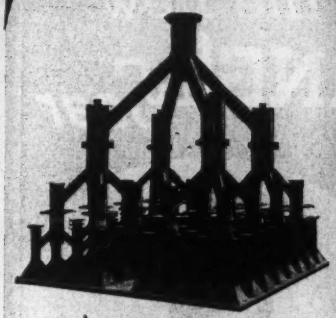

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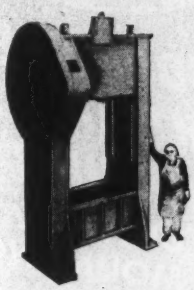

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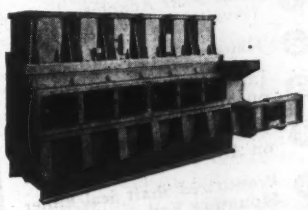

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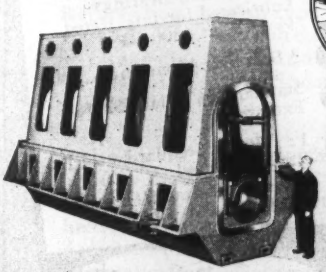

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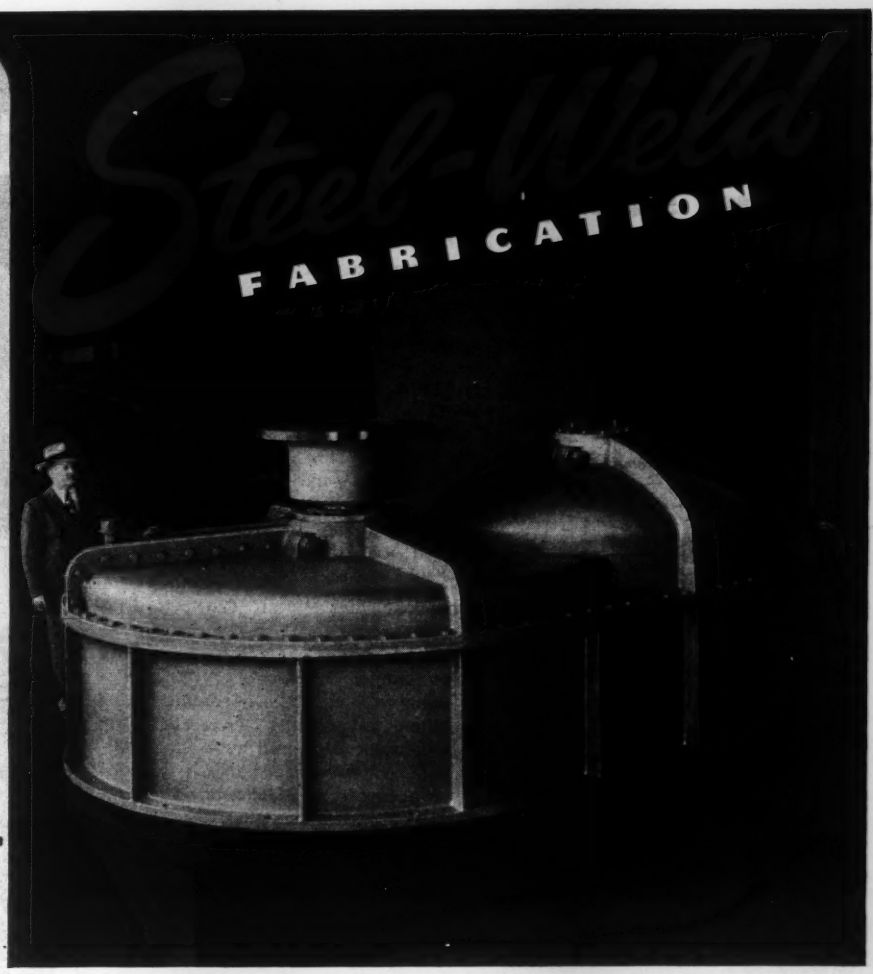

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TOOLPOST AND BENCH GRINDER. Fits lathes of 9 to 13-in. swing for external cylindrical grinding, mounts on shaper, planer or milling machine for surface grinding. Machine is quickly converted for bench use. Powered by ¼-hp, 5000-rpm, constant-speed motor, grinder is accurate to 0.0002-in. The Dumore Co., Racine, Wis.

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FORK LIFT TRUCK. Capacity, 10,000 lb. Dynatork Drive transmits engine power through magnetic field, eliminating friction clutch. Conventional transmission replaced by constant-mesh forward and reverse gearing. Powered by 6-cylinder gas engine developing 50 bhp at 1800 rpm. Dimensions: Outside turning radius, 104 in.; inside turning radius, 12 in.; overall length, 107 in.; wheelbase, 66 in.; overall width, 50½ in. Machine turns in intersecting aisles 88 in. wide. Clark Equipment Co., Industrial Truck Div., Battle Creek, Mich.

FORK LIFT TRUCK. Pneumatic and cushion-tire models with 2000-lb capacity at 24-in. load center. Standard masts have collapsed height of 64½ in. with 85-in. lift,

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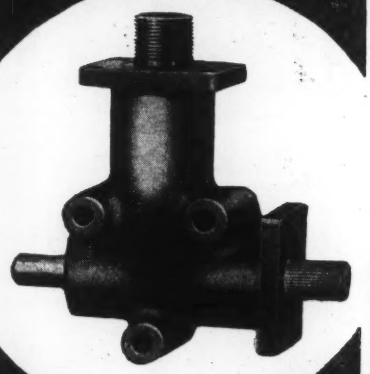

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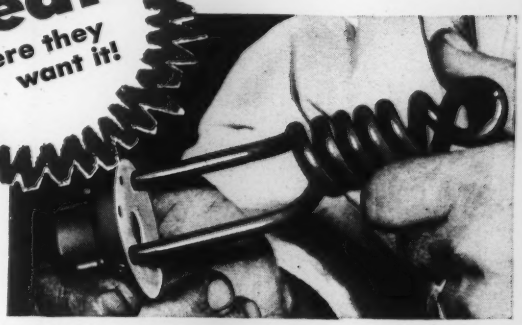


The Calrod heater is easily formed into a helical coil, cast into brass concentric to a $\frac{3}{16}$-inch copper-tube coil, and the compact unit acts as a flash boiler.

Madewell Products, Inc. puts steam on the beam in their Electro Spray with "built-in" G-E Calrod heaters!

Like hundreds of other machinery manufacturers, Madewell Products, of Oakland, California, have found that the simplest, easiest, most reliable way to build heat into their product is with G-E Calrod heaters. And in two years there hasn't been a single heater failure in the field!

Many times the heat source is a vital part of your machine. Because of the many types of G-E heaters...because of the wide range of standard sizes, ratings, and sheath materials in which these heaters are available . . . they provide a ready, practical solution to almost every conceivable problem of building low-cost, efficient heat into machinery.

Before You Design your machinery or equipment for repetitive manufacture, contact your nearest G-E Apparatus Sales Office and get the recommendations of an Industrial Heating Specialist . . . it will pay you BIG dividends. And . . .

FOR THE NEW, FREE 1950 CATALOG, GEC-1005A, write us on your letterhead. And, if you'll also tell us about your heating jobs, we'll send you application bulletins to help you select and correctly apply the right heaters to give you heat *where* you want it . . . *when* you want it . . . and in the *amount* you want it. ***Sect. 720-19, Apparatus Dept., General Electric Co., Schenectady 5, N. Y.***

The Madewell Electro Spray, generates superheated steam which blasts particles of insecticide into the air for prolonged suspension with increased killing effects.

GENERAL ELECTRIC

720-19

with variety of special lifting heights available. Feature two-speed forward and two-speed reverse transmission, single hydraulic mast control lever, and gear shift levers mounted on steering column. The Buda Co., Harvey, Ill.

Plant Equipment

MULTISTAGE PUMP. Centrifugal, high-pressure pump for shallow-well installations. Vertical unit stacks several stages over one another with discharge pressure proportional to number of stages. Volute of each stage divided into 5 sections to reduce space required. Can be converted to deep-well pump by adding hydro-ejector. Provided with two sets of tapped openings for pressure and suction lines, at bottom and side of unit. Advance Pump Co., Berkeley, Calif.

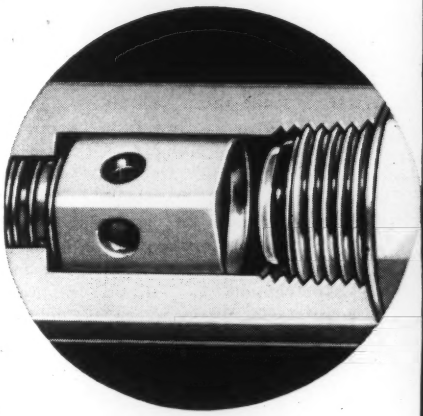
COMPRESSORS. Reciprocating type units for commercial air conditioning and refrigerating applications. Operate on Freon 12, Freon 22 or ammonia. Four-cylinder model 5J40, using Freon 12, has 100-ton cooling capacity for air conditioning, 65-tons for refrigeration. Six-cylinder Model 5J60, using Freon 12, has 150-ton capacity for air conditioning, 100 tons for refrigeration. Compressor operates at 900 rpm with Freon 12, can be direct or belt driven by motor, gas or diesel engine. Carrier Corp., Syracuse, N. Y.

FLOOR MACHINE. For scrubbing, waxing and polishing. Also can be used for sanding, steel wooling, pumicing, etc. Features rotary switch on handle, hand solution control, adjustable handle, self-raising wheels, automatic brush coupler, and quick-change snap on brush rings. Breuer Electric Mfg. Co., Chicago, Ill.

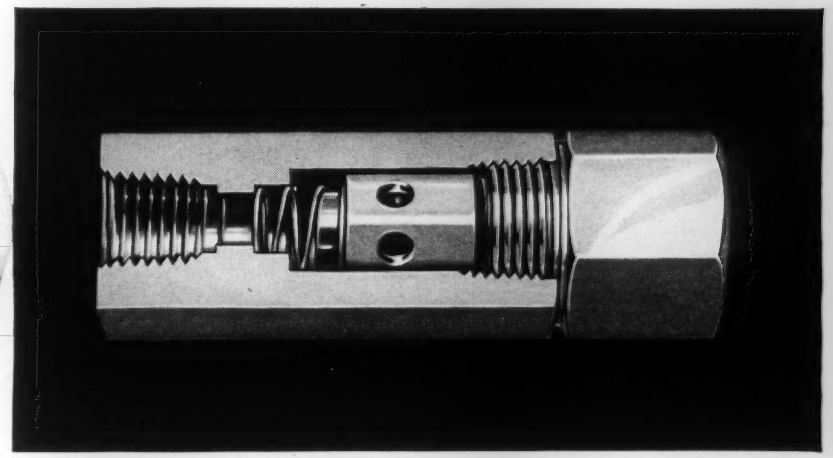
Power Plant Equipment

STANDBY POWER PLANT. Capacity, 5 kw; will start single-phase motors to 3 hp. Powered by 2-cylinder, air-cooled Wisconsin engine operating at 1800 rpm. High tension magneto permits hand cranking, electric starting available. With automatic transfer switch; voltage regulation held to 8 per cent on noninductive loads. Self-excited unit is for 110/220-volt, 60-cycle, 3-wire service. Kato Engineering Co., Mankato, Minn.

STEAM TURBINES. For drives requiring quiet, smooth operation or for use in explosive atmospheres. Model TE-5 measures 26 by 16 by 16 in., delivers 5 hp at 2000 to 3600 rpm. Larger Model TE-15 delivers 15 hp at 3600 rpm. Construction good for close-coupled units, can



In "Open Position."



In "Closed Position."

Avoid costly air leakage • • • with this

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Soft Seat Type Pneumatic Check Valve

Kohler K-1354 Check Valve can be furnished as follows:

Size: ⅛ ", ¼ ", ⅜ ", ½ ", ⅝ ", ¾ ".

Connection: Internal Pipe, External Pipe, Tubing, or combinations as specified.

Proof Pressure: Up to 7500 PSI.

Leakage: Zero.

Material: Brass, Aluminum or Steel.

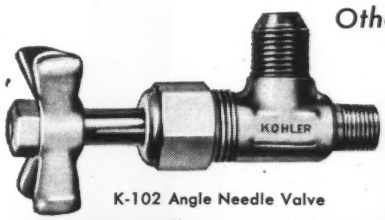
Flow: As specified.

Kohler quality valves, produced with precision workmanship, enable you to install trouble-free pneumatic systems. The K-1354 check valve is small, light in weight and versatile. By modifying the spring, opening pressures up to 100 PSI can easily be obtained.

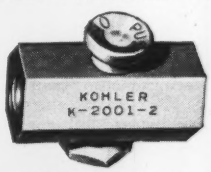
Kohler angle needle valves, 3-way plug valves, pneumatic check valves and on-off valves will meet a variety of requirements as integral precision parts of your system.

Kohler valves, fittings and other precision parts are made in a wide range of types and sizes. Complete facilities for forging, machining and anodyzing centered in one plant help speed up deliveries and service. Kohler engineers will gladly develop valves to meet your special requirements. If you do not have a copy of our complete, illustrated Precision Parts Catalog, send for a copy today. Kohler Co., Dept. 1-V, Kohler, Wisconsin. Established 1873.

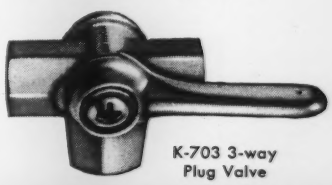
Other Kohler Precision Valves for Pneumatic Systems



K-102 Angle Needle Valve



K-2001 On-off Valve



K-703 3-way Plug Valve

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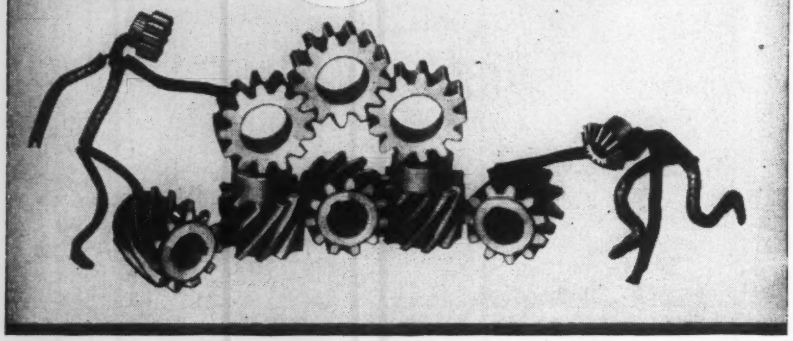

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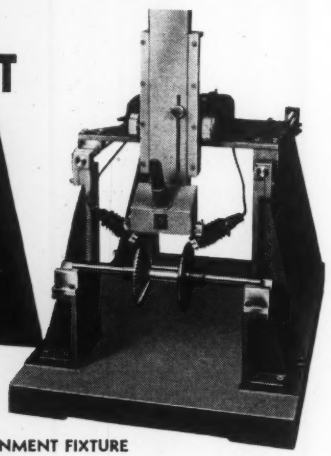

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be run vertically or horizontally. New governor valve and control mechanism provides close speed regulation without hunting. Moon Manufacturing Co., Chicago, Ill.

SMALL INDUSTRIAL ENGINES. Air-cooled, with suction type carburetors and underslung fuel tank for reduced profile. Model AC-5 develops ¾ to 1 hp, AC-6 provides 1½ hp. Both are single-cylinder, four-cycle, L-head engines having bore and stroke of 2⅛ and 2 in. Displacement is 7.1 cu in. and compression ratio 5.2 to 1. Include oil bath air cleaner, flywheel type magneto, blower housing, muffler, 1-qt fuel tank, air-vane governor and rope starter pulley. Continental Motors Corp., Detroit, Mich.

Processing

CRUSHER. Double rotor Knittel units for materials which tend to clog and reduce crusher capacity. Rotors driven by separate direct-coupled motors. Synchronization unnecessary since rotors operate independently. Sized slots in crusher gate determine max size of material. Stephens-Adamson Mfg. Co., Aurora, Ill.

Service Equipment

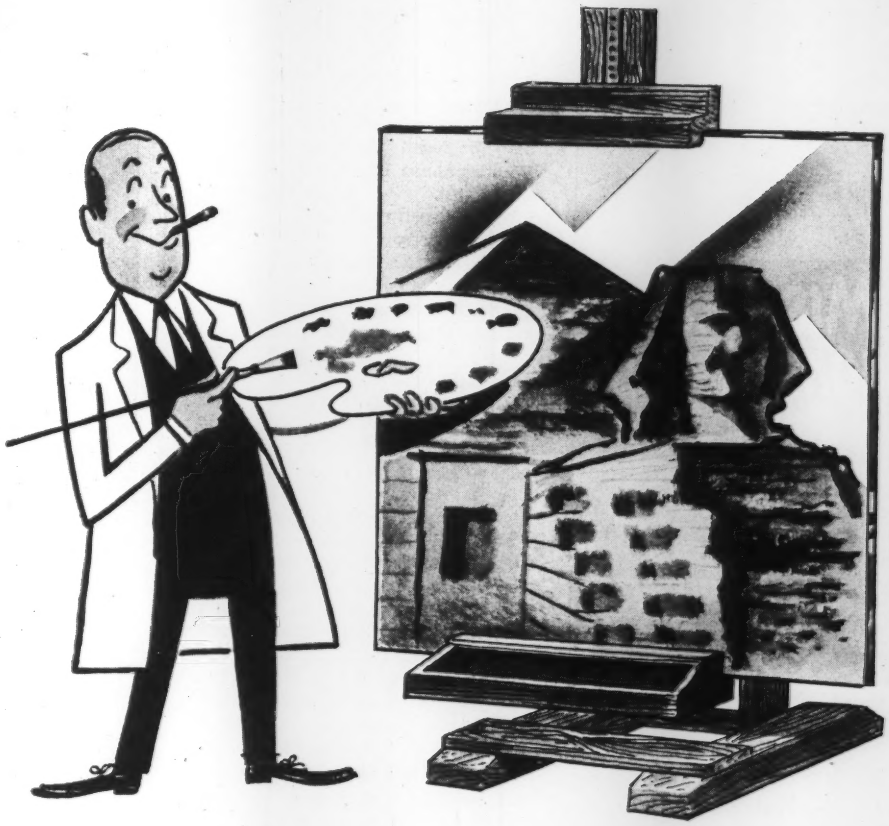
LUBRICATORS. Individual cabinet type units for chassis, gear and drain service. Lubricators dispense from 100-lb drums. Chassis unit is air powered with single-cylinder pumping unit having 36 to 1 piston ratio. Gear lubricator has hand pump, with meter registering to 8 pints. Funnel height of oil drain adjustable from 43½ to 63½ in. All cabinets measure 43½ in. high, 21⅛ in. diameter. The Aro Equipment Corp., Bryan, O.

PORTABLE LUBRICATOR. For service stations, car dealers, etc. Powered by double-acting pump with 36:1 piston ratio delivering 6000 lb grease pressure. Automatic oiler keeps pump lubricated. Control nozzle gives choice of controlled shots or continuous flow. Cabinet holds 50-lb drum or 60-lb bulk lubricant. Unit dolly mounted. Aro Equipment Corp., Bryan, O.

FLUID DISPENSER. For automatic transmission fluid. Dispenses directly from original 100-lb containers. Unit has 7-ft hose, fluid meter, hand pumping lever, straight and curved ball check nozzles. Available with plate or band type dolly or 2-wheel hand truck. Aro Equipment Corp., Bryan, O.

Testing and Inspection

INSULATION TESTER. For development and control of insulating coatings for copper wire and for other applications involving dielectric stress



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studies. Consists of high-voltage transformer, motor-driven autotransformer, indicating voltmeter, and mercury cups or terminals. Two models rated at 35 kv, 5 kva and 12 kv, 0.5 kva. Instrument can also be used for fatigue testing. Westinghouse Electric Corp., Pittsburgh, Pa.

SPECTROPHOTOMETER. Double-beam infrared spectrophotometer combines high resolution and sensitivity with speed and accuracy. Records in per cent transmission against linear wavelength on large charts. Scanning speed ranges from 3 minutes to 100 hours for rock salt region. Overall range, less than 2 microns to 15 microns in rock salt region. Chart size, 11 to 32 in.; chart scales uniform from 1 to 50 inches per micron by integral factors. Perkin-Elmer Corp., Glenbrook, Conn.

SHIPPING PACKAGE TESTER. For vibration and impact testing without removing package from testing table. Simulates forces and vibration motions and magnitudes of package in railway car or truck. Table carrying package raises up to 20 in., then dropped. Has 2000-lb electric hoist to raise tester. L. A. B. Corp., Summit, N. J.

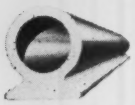
GEAR TESTER. For sound testing of external and internal gears and planetary gear assemblies. Two sizes, one for gears to 14 in. diameter and other for gears to 24 in. diameter. Tests run at 4 different speeds in either direction with or without gear loading. Noisy gear sets can be corrected before assembly. Air clamping available to expedite loading and unloading. National Broach and Machine Co., Detroit, Mich.

ELECTRONIC TILE SORTER. Detects invisible air pockets in tile. Detects flaws in 4¼ by 4¼ by ¼-in. double-fired tile when in bisque state (after first firing). Can be adjusted to reject any percentage of tiles with air pockets. Capacity, 10 tiles per second. Rejects may be mechanically removed from line or marked with dye for hand removal. Electronic Associates Inc., Long Branch, N. J.

VIBRATION FATIGUE TESTER. Provides stepless acceleration from 10 to 100 cps, with infinite speed range from electronic drive. Tests parts and components to 100 lb on 15 by 18-in. table which has simple harmonic motion in horizontal plane. Displacement adjustable from zero to 0.125-in., with 10g available with 100-lb load on table. All American Tool & Mfg. Co., Chicago, Ill.

AUTOMATIC RECORDER. For checking and obtaining permanent charts of involute tooth forms, tooth spac-

Consolidated Vultee Aircraft Corporation



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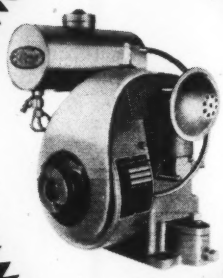

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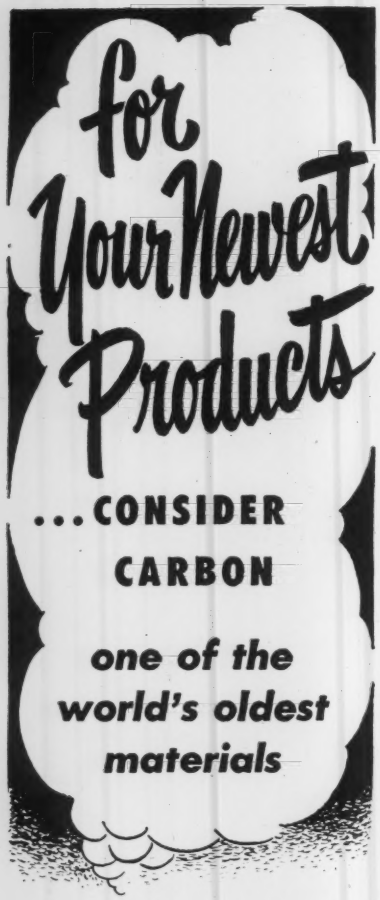

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ings, leads, contours, thread forms, etc. Plus or minus error to 0.002-in. can be automatically recorded. Includes selective two-speed chart drive and standardized interchangeable electronic gage head. Pen movement is ⅛-in. per 0.0001-in. of checker indicator finger movement. Chart drives give ½-in. of travel for either 1 or 2 degrees of work rotation. Michigan Tool Co., Detroit, Mich.

PRESSURE TESTING INTENSIFIER. For static testing of boilers, piping systems, compressor cylinders, etc., where static pressures to 23,000 psi are required. Operation requires only connection to standard compressed air line. Variable static hydraulic pressures set by regulator valve equipped with dial type air pressure gage. Line air pressures to 90 psi required. Units weigh 80 lb, is mounted on two-wheel rubber tired carriage. The Cooper-Bessemer Corp., Mt. Vernon, O.

SHOCK TESTING MACHINE. Platform handles equipment 36 by 36 by 30 in. weighing to 150 lb. Steel-sheathed blocks on underside of platform penetrate sand in base box to obtain decelerations to 100g without rebound. Duration of deceleration adjustable between 6 and 32 milliseconds. Machine requires floor space 50 by 61 in., is 10½ ft high, weighs 3000 lb. The Barry Corp., Cambridge, Mass.

TEST SIEVE SHAKERS. Vibrating shaker for laboratory screen analysis work. Vibrations produced by electromagnetic drive energized by rectified, half-wave a-c power, 3600 vibrations per min from 60 cycle current. Vibration amplitude regulated by adjusting rheostat. Timer provides timing of test periods. Unit handles six 8-in. diameter sieves. Syntron Co., Homer City, Pa.

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POWER PLANE. Max cutting width, 1 13/16 in. Hardened steel cutter operates at 20,000 rpm. Adjustable apron permits bevel cuts from zero to 25 degrees. Overall dimensions; 11¼ in. long, 8½ in. wide, and 5 in. high. Weight, 7 lb 10 oz. The Porter-Cable Machine Co., Syracuse, N. Y.

WOODWELDER. For furniture or other wood fabrication. Rated at 5 kw. Unit uses 220 or 440-volt, 50/60-cycle, 3-phase power input, has output efficiency of approximately 65 per cent. Overload relay and forced draft cooling system standard equipment. Dimensions; 24 by 24 by 36 in. Weight, 350 lb. Woodwelding Inc., Burbank, Calif.

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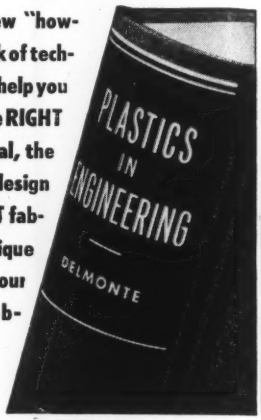

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